Construction Methods

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IN THIS ISSUE

Winter Construction

as a means of unemployment relief

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FIELD PRACTICE

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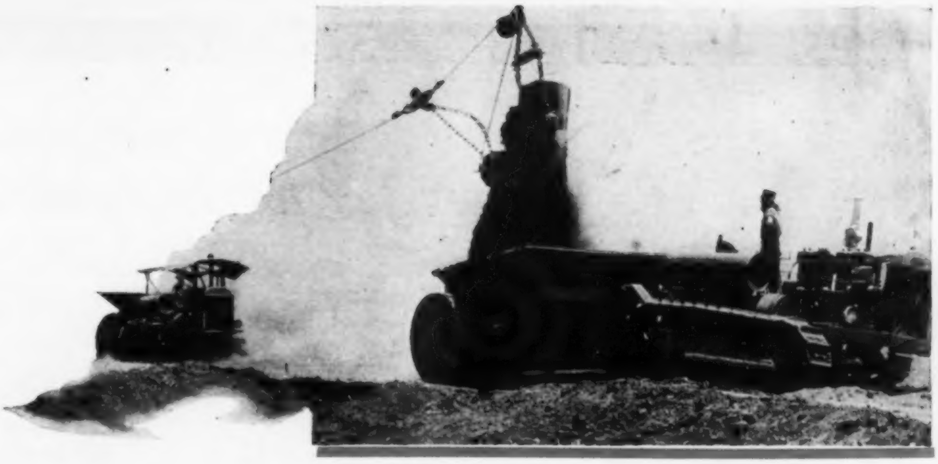
The Editor Notes—



Business Recovery Through Construction

FOR expanding employment on a nationwide scale, the Emergency Relief and Construction Act has provided a credit distribution reservoir of more than two billion dollars which may now be tapped to divert a flow of funds into public works construction and other projects of a self-liquidating character. The purpose of the act, which became effective July 21, is three-fold: to relieve destitution, to broaden the lending powers of the Reconstruction Finance Corporation and to create employment by providing for and expediting a public works program.

• To accomplish these results funds are made available in three categories, as follows: $300,000,000 loans to the several states and territories for "relief and work relief to needy and distressed people"; $1,500,000,000 loans through the Reconstruction Finance Corporation to public bodies and private corporations for projects "self-liquidating in character"; $322,224,000 for emergency construction of certain authorized public works, including $120,000,000 for federal-aid highway construction performed before July 1, 1933, and $10,000,000 for continuing the construction of the Hoover dam. The grand total of funds thus ready for immediate use is $2,122,224,000.

• It is significant that the Federal Government, in its efforts to relieve unemployment and to stimulate business and industrial activity, has chosen the construction industry as the spearhead for its attack. The vast credit resources of the nation which the Relief Act has made available, however, are obviously not designed with the narrow objective of improving conditions in any single field of activity such as construction, but rather through construction, with its ramifications into all industry, it is hoped to bring about a general business and trade revival.

• The Relief Act, therefore, places squarely upon engineers, contractors and public officials—everyone with a stake in the construction industry—the responsibility of putting to work, at once, the millions that are now available for reviving construction programs, particularly through the medium of self-liquidating projects. Communities throughout the country should lose no time in canvassing their local needs, submitting their projects for approval by the engineering board of the R.F.C. and getting work started now. Prompt action will mean jobs for thousands of men now idle, and funds, on pay day, that will flow back into the purchase of local goods.

• The program will be successful only if there is an immediate and complete utilization of the credit resources that are ready to be put to work. A partial use of the relief funds will spell failure; every dollar must be taken up. Now is the time for the men of the construction industry to make their influence effective in rousing public opinion to a realization of the need for getting construction work started on a broad scale as the first step toward business recovery. Construction must, and will, fulfill the hope and the confidence that the Government has reposed in it through the Relief Act.

CONSTRUCTION METHODS

A monthly review of modern construction practice and equipment

ROBERT K. TOMLIN, *Editor*

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A Job for Everyone

AS we have pointed out on this page, a normal construction program is a major essential of our national prosperity. America still is in its construction era. We count upon the volume of trade and the employment that result from the continuous investment of capital in fixed structures and facilities as very likely to mean the difference between poor times and good times.

And construction dollars are especially effective dollars with respect to stimulating general trade. That is one reason why we enjoy so great a prosperity in times of normal growth and expansion and suffer so severely when construction operations are curtailed or suspended.

For construction dollars add directly through wages and salaries to the buying power of the community without any counterbalancing increase in the current production of commodities which must be bought by the consumers. They are, therefore, a clear addition to the capacity of the community to buy the goods and services produced by manufacturers and utilities.

That is one reason why the nation has turned to the construction industry as the most promising road to a revival of general trade; that is the reason for the relief and construction bill enacted by the recent Congress. This act provides not only for Federal construction but also for the extension of Federal credit through the Reconstruction Finance Corporation to assist cities, counties, and states in their public works programs.

But these measures cannot achieve their full usefulness, they cannot provide the desired stimulus to general trade unless the local public works programs are taken in hand and pushed vigorously right now.

Quite aside from this primary purpose there is, as a matter of self-interest, every reason why cities, counties and states should avail themselves of this opportunity. The need for many public improvements is manifest; it will be more so with a return of normal activity. The cost of construction work is at its lowest ebb for many years; already it is beginning to rise to more normal levels. A public works program will provide employment for thousands, both directly and indirectly, and through it the community will have in the end something to show for its relief expenditures. After all, the way to relieve unemployment is to provide employment; that is nothing but sound sense.

Viewed from any angle, there is ample reason why every engineer, constructor, public official and trade group should see that their communities avail themselves of the chance here offered to stimulate general trade, provide employment and add to their community facilities at low cost.

There is a job for each of these groups in each community to seek out such projects for wise and useful investment and to see that they are properly presented to the authorities who are directing this national effort for trade revival.

Willard Chevalier

Publishing Director

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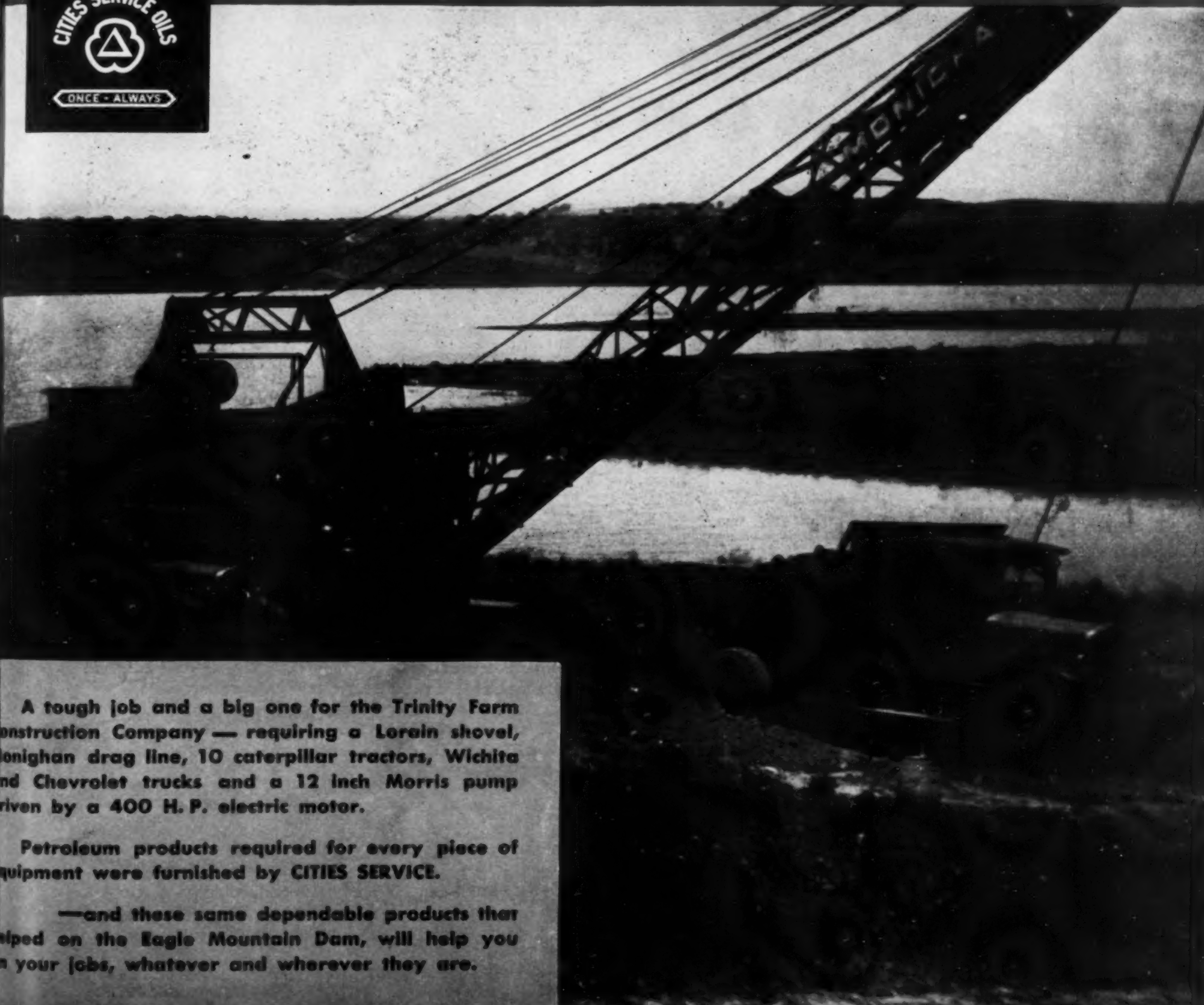
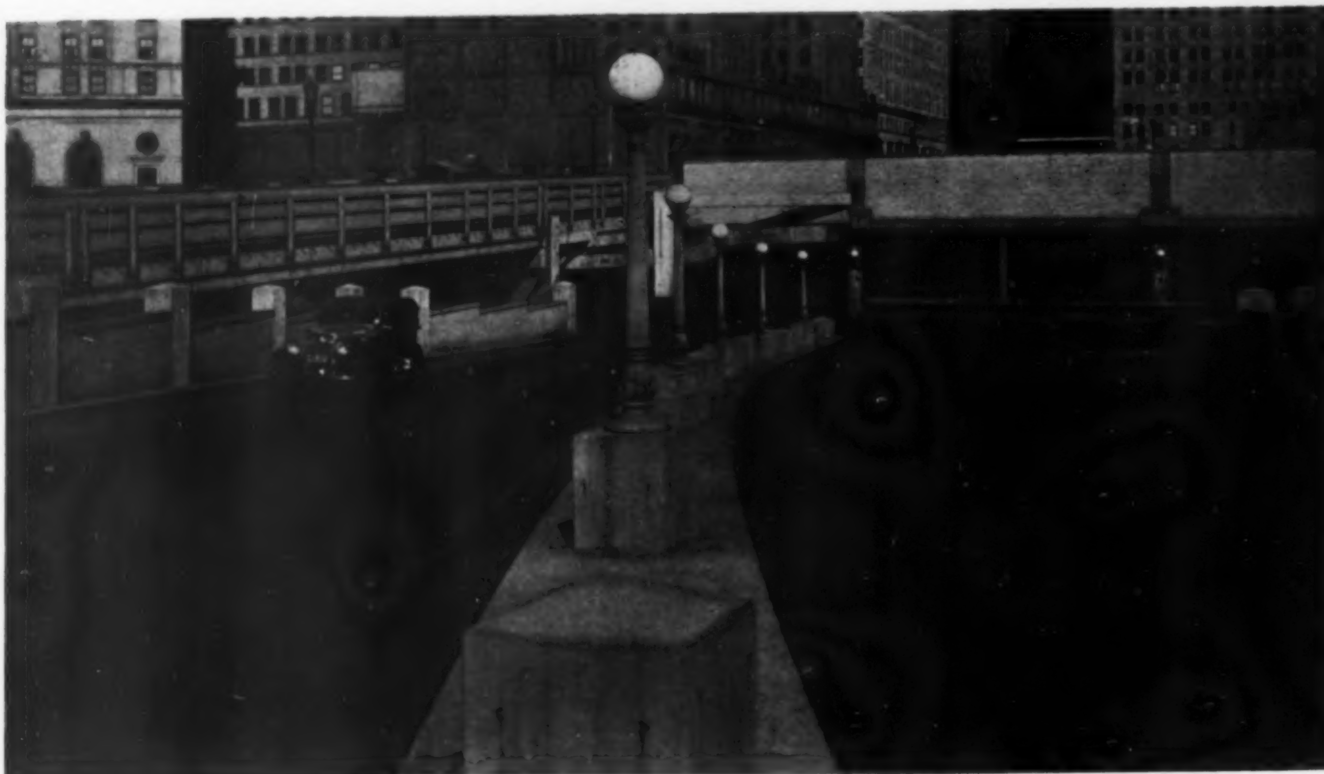
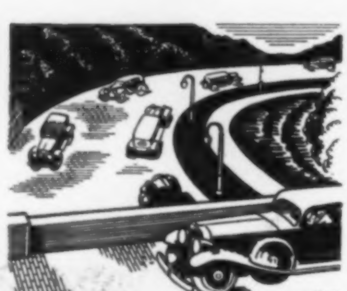


FOR RAMPS? THE ANSWER IS BRICK



Brick-paved Ramp — New Union Terminal, Cleveland, Ohio

IN the selection of brick for the terminal ramp, Cleveland followed the excellent precedent set by the brick-paved approaches to the Pennsylvania Station in New York City, and the Union Stations in Chicago and Pittsburgh.



The constant grind of heavy vehicular traffic — hour after hour, and day after day — never ceases. It requires a paving surface that is smooth, durable, safe—and most economical in cost per year of service.

The terminal area in Cleveland, Ohio, utilizes air rights over the trackage required by the Cleveland railway terminal development. Ample provision has been made for the surging flow of motor vehicles which transport passengers and baggage to and from the Union Station.

This was accomplished by means of a double driveway ramp; and, in keeping with the high standard of construction rigidly adhered to by the engineers in charge of this notable project, brick was used as the paving material best suited for the job. The same uninterrupted twenty-four hour schedule that has become a tradition in railroad service also characterizes the service of a brick pavement.

For ramps also then, the answer is BRICK!

•

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J. B. McCrary Engr. Corp., Atlanta, Ga. . . . own 6 machines
Hooper Const. Co., Bunnell, Fla. . . . . own 3 machines
C. E. Bussey & Son, Inc., Mobile, Ala. . . . . own 2 machines
Chas. C. Aderholdt, Hughes, Ark. . . . owns 3 machines
Sutton Bros., Inc., Nashville, Tenn. . own 12 machines
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Nixon & Phillips, Birmingham, Ala. . own 14 machines
Wills Const. Co., St. Louis, Mo. . . own 7 machines
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Houston Trans. Co., Houston, Texas . own 5 machines
John J. Quinn Co., Inc., Bedford, Ind. . . . own 6 machines
J. Lee & E. A. Vilbig, Inc., Dallas, Texas . . . . own 5 machines
Midland Const. Co., Clarksdale, Miss. . own 5 machines
J. D. George Const. Co., Donna, Texas . . . own 6 machines
Tom Green, Oklahoma City, Okla. . . . . owns 9 machines
A. A. Davis & Co., Oklahoma City, Okla. . . . . own 6 machines

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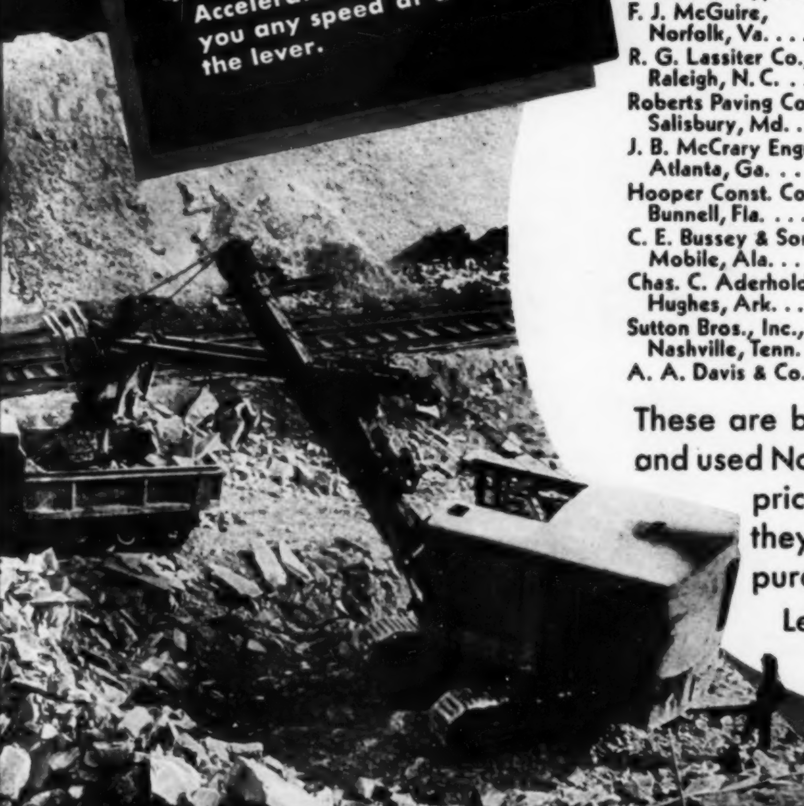

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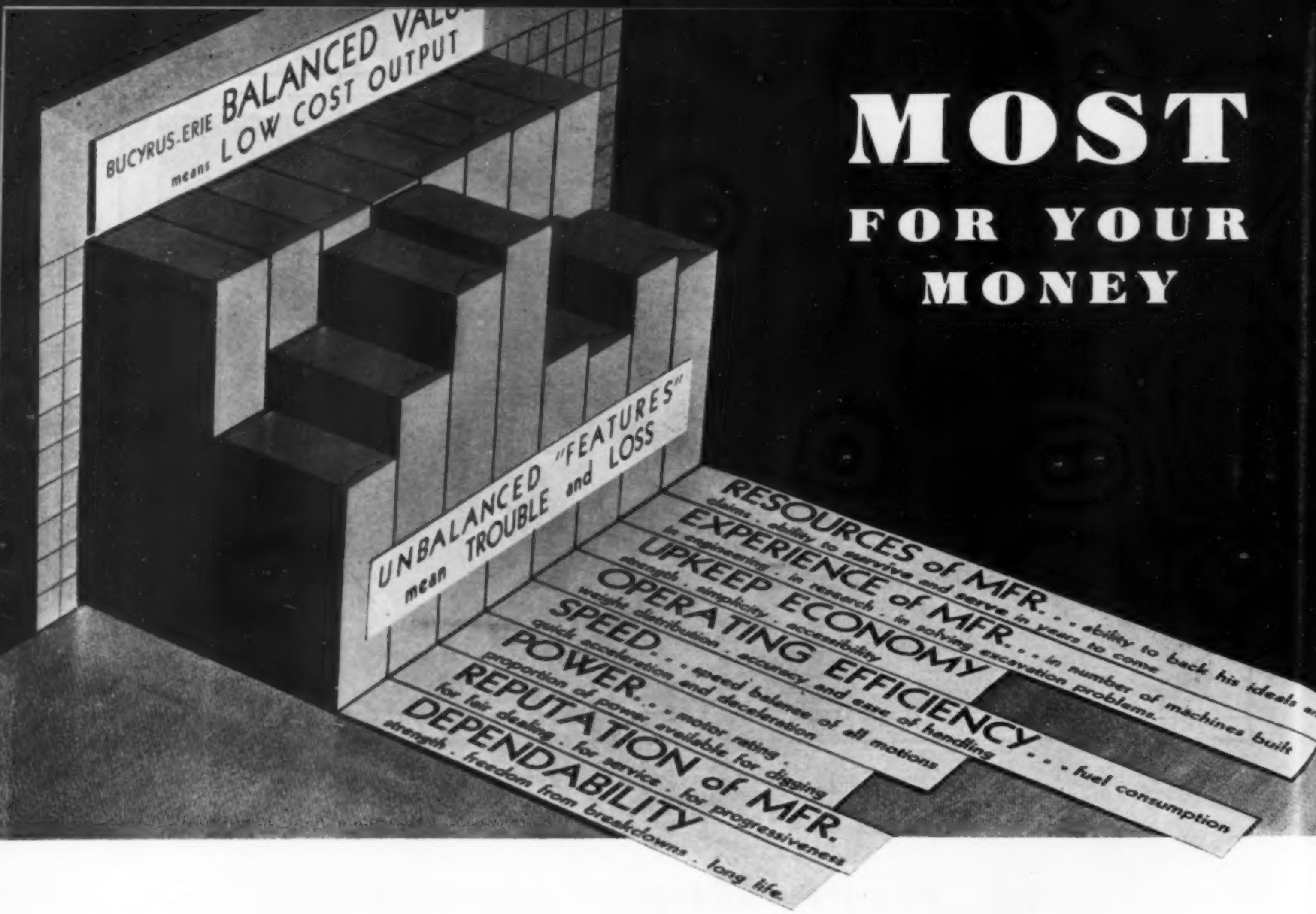

BALANCED VALUE *versus* UNBALANCED "FEATURES"

PROFITS from digging come as a direct result of full value in all features of the excavating machine — a perfect balance between all the considerations which the owner must face during the machine's lifetime.

Do not purchase any machine — new or used — without careful study on all counts. Measure the machine's dependability, power, speed, operating efficiency and upkeep economy; weigh the reputation, experience and resources of the manufacturer.

See that each factor is balanced in its proper proportion to all others — one or two strong features cannot make up for lack in the others of these eight essentials.

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Construction Methods

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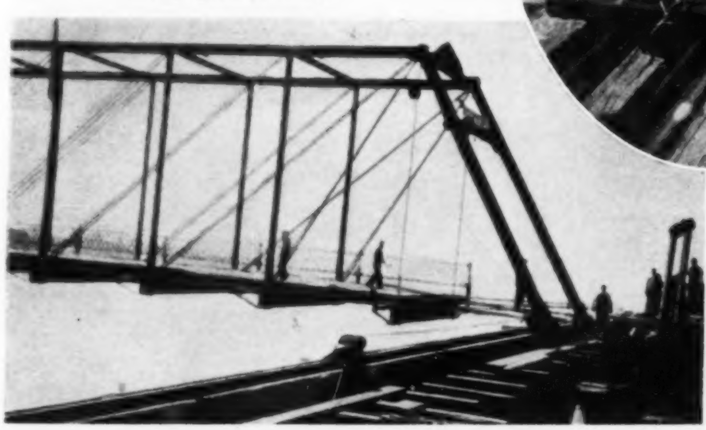
ROBERT K. TOMLIN, *Editor*

VOLUME 14 NEW YORK, SEPTEMBER, 1932 NUMBER 9

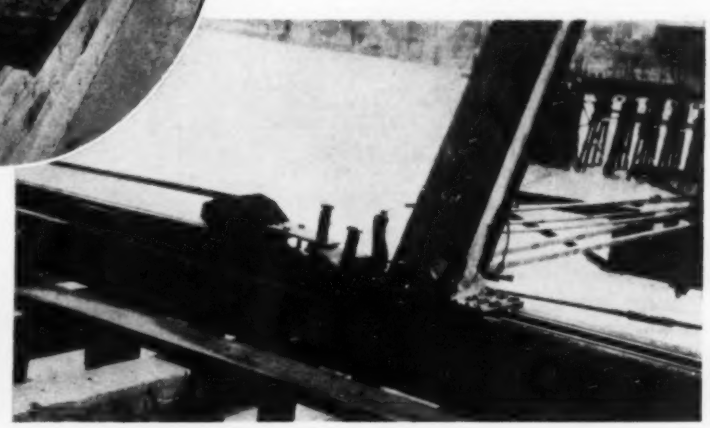
OLD TRUSS SPANS are moved 150 ft. downstream to make way for new concrete arch bridge. Four trestles support greased steel rails on which three old spans slide. Farthest span is in new position, and second span is in transit.

STEEL SHOES *(left)* under end posts of truss spans slide on greased rails.

FOUR-SHEAVE BLOCK AND TACKLE *(below)*, powered by hoist engine on bank, pull one end of span along greased rails.



MOVABLE BLOCK *(below)* of block-and-tackle hauling gear is pinned to shoe under end post of steel span.



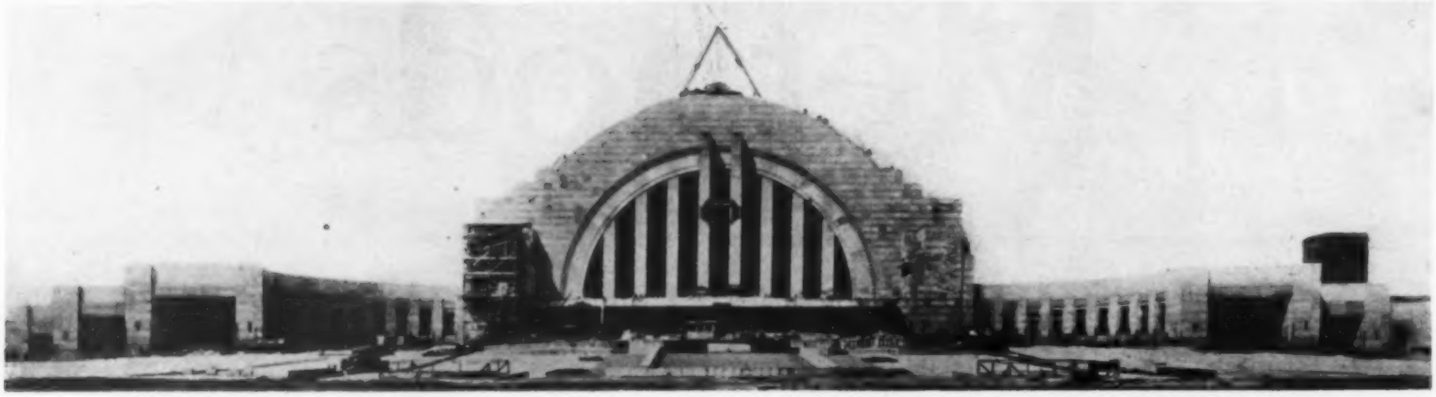
Moving of Old Bridge Clears Way for New

CONSTRUCTION of a $300,000 concrete arch bridge over the Maumee River at Napoleon, Ohio, involved as a preliminary removal of an old bridge 150 ft. downstream, where it continued to serve traffic until the new and wider structure was completed. One span at a time was pulled downstream on greased steel rails, as illustrated.

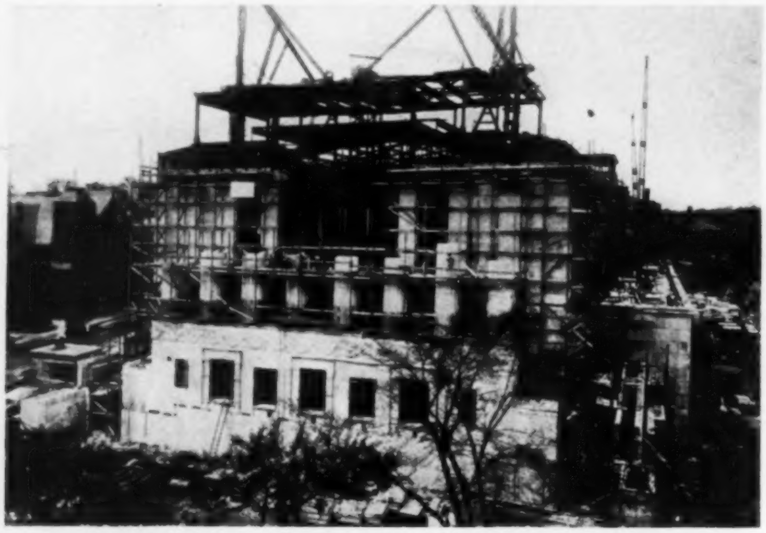
The new structure, 750 ft. long, is a spandrel-filled, reinforced concrete arch bridge with seven 95-ft. clear spans. Excavation totaled 18,000 cu.yd. and materials included 460,000 lb. of structural steel, 67,000 sacks of Universal cement and 314 carloads of granulated slag to fill the spandrels. A distinctive feature is the word "Napoleon" spelled with brick in the pavement of the bridge for the benefit of aviators.

Cold weather methods permitted the placing of concrete for footings and piers at 14 deg. F. below zero, according to Harry R. Wagner, assistant construction engineer, who took the accompanying pictures. The Miller-Taylor Construction Co., Waterloo, Iowa, was contractor.

This Month's

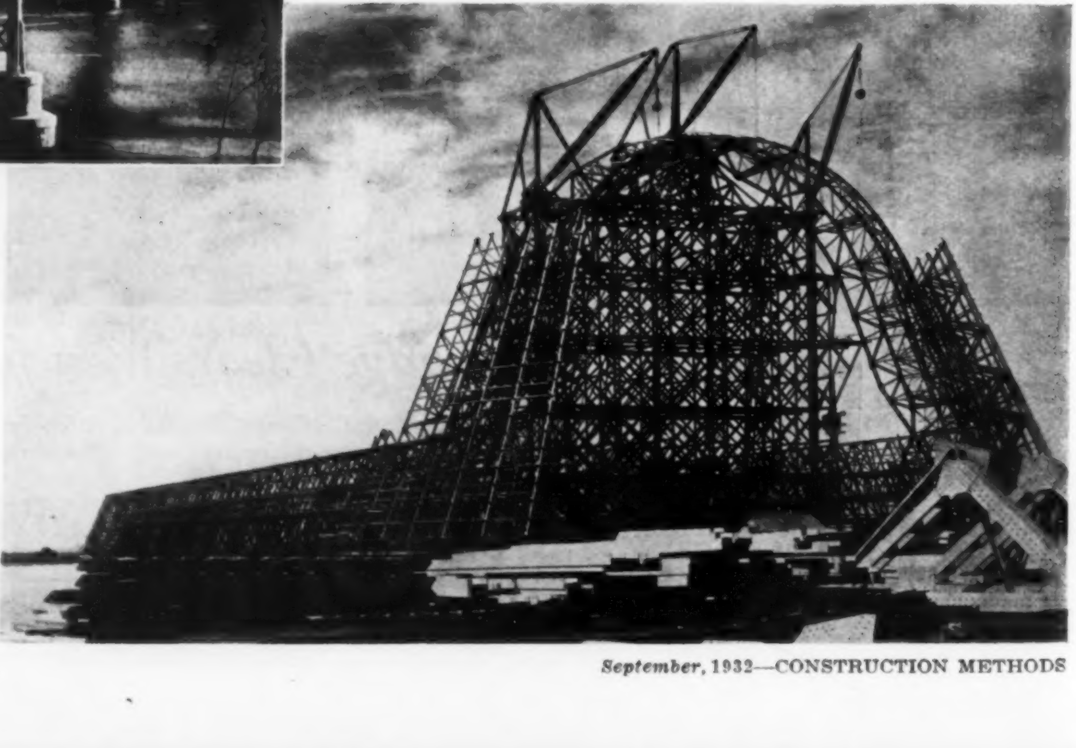


SEMI-DOME TYPE OF ROOF covers new union passenger terminal at Cincinnati, Ohio, designed for Cincinnati Union Terminal Co. (H. M. Waite, chief engineer) by O. S. Payzant, engineering associate of Fellheimer & Wagner, architects and engineers, New York. Parallel arched trusses of steel are placed at different elevations to fit curved outline of dome, while highest and largest trusses carry a barrel-arch extension of the dome. Maximum span for dome is 202 ft. and for arch 209 ft. Erection by Bass Construction Co., sub-contractor for James Stewart & Co., Inc., general contractor.



WAR MEMORIAL AUDITORIUM, of brick, stone and steel construction, is nearing completion at Worcester, Mass. Structure, 188x288 ft. in plan and costing about $2,000,000, is being built by George A. Fuller Co., of New York, from plans by L. W. Briggs & Co., architects of Worcester.

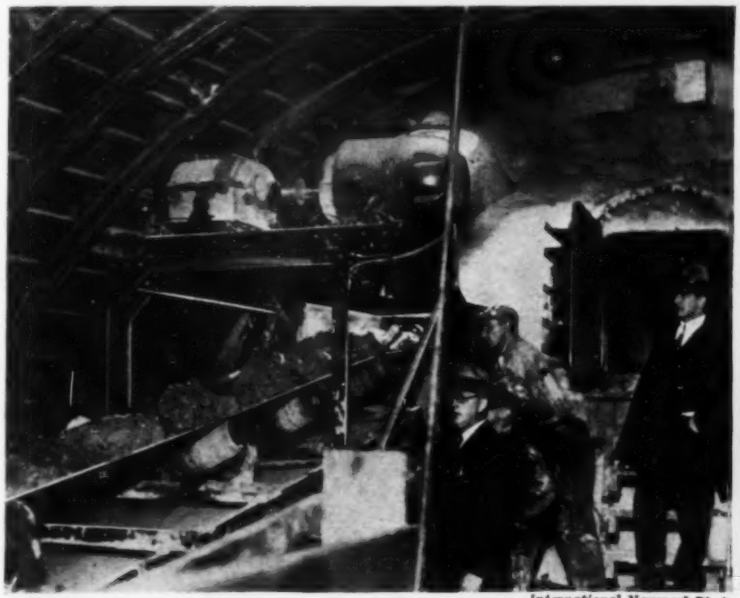
PRIZE BRIDGE, Waldo-Hancock suspension structure, with main span of 800 ft., over Penobscot River at Bucksport, Maine, wins award for beauty by American Institute of Steel Construction. Design by Robinson & Steinman, New York. Erected by American Bridge Co.



HANGAR *(right)*, of unusual steel frame construction, will house dirigibles at U. S. Navy Base, Sunnyvale, Calif. Wallace Bridge & Structural Steel Co., of Seattle, Wash., is erecting structure approximately 200 ft. high and 1,200x300 ft. in plan, at cost of $1,166,000.

"News Reel"

OHIO RIVER BRIDGE, between Evansville, Ind., and Henderson, Ky., on U. S. Highway No. 41, has recently been completed at cost of $2,079,000 and opened to traffic. Total length of structure is 5,395 ft. Main cantilever superstructure has four spans of 540, 600, 720 and 432 ft. Kansas City Bridge Co., erected cantilever spans.



International Newsreel Photo

BELT CONVEYORS are used by Silas Mason Co., contractor, of New York, to handle muck from the new 32-ft. diameter vehicular tunnel under Boston Harbor, connecting Boston with East Boston, Mass.

CELLULAR TYPE COFFERDAM of steel sheet piling aids construction of Marseilles, (Ill.) dam across Illinois River under direction of Army Engineer Corps. View shows concreting of land connecting wall.

19-STORY FACTORY OVER RAILROAD YARD. Starrett Bros. & Eken, Inc. complete Starrett-Lehigh building occupying entire city block along Hudson River waterfront in New York. Base structure involving erection of 15,000 tons of steel supports flat concrete slab superstructure, with floor space of 1,800,000 sq.ft. Elevators take motor trucks to loading platforms on any floor.

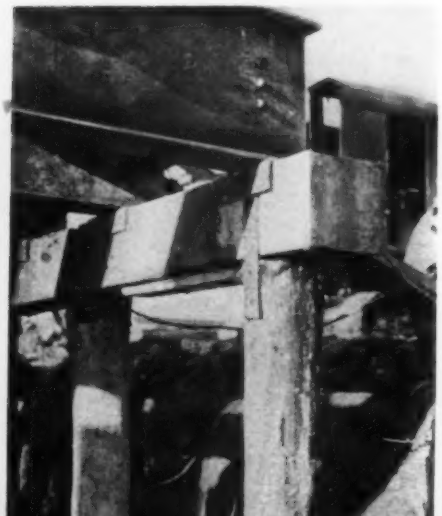
Front Cover Photo by Ewing Galloway

DUAL HEATERS raise temperature of mixing water on Ohio contract of Ross Construction Co., building concrete-beam bridge with three 45-ft. spans. Centrifugal 2-in. pump delivers water from stream to open tank heated over fire. Second 2-in. centrifugal pump forces water from this tank through coil in kerosene hot-blast salamander to tank on mixer.

Unemployment Relief Spurs Winter Construction of Highway Bridges

(*First of a series of articles on winter construction practice*)

INSTRUCTIVE data on methods and costs of winter bridge construction are provided by the records of several states, notably Ohio, which last winter undertook extensive bridge programs to relieve unemployment. The winter programs represented the most comprehensive test ever attempted of cold-weather bridge construction. Ohio spent a special appropriation of $3,500,000 in building 351 small highway bridges, and Michigan, as a second outstanding example, expended a large portion of its unprecedented $10,000,000 winter highway construction budget on bridge and grade-separation structures. Intensive preliminary planning, which took into consideration the need of distributing the work to provide employment in those sections most needing relief, paved the way for



STEEL I-BEAM STRINGERS welded to bearing plates on timber caps of wood-pile bents span two 43-ft. openings of creosoted timber bridge built by McDonald Construction Co., of Norwalk, Ohio, for state department of highways. TIMBER CAP *(right)* is strapped to creosoted wood piles.

efficient execution of the winter programs.

Increase in Cost—Because of the extent and diversity of its winter bridge program, Ohio possessed an unparalleled opportunity to make a broad and accurate comparison of the costs of summer and winter construction. For the benefit of *Construction Methods* readers, J. R. Burkey, chief engineer of bridges of the Ohio department of highways, made a detailed study of bid prices to determine the increased cost of a typical bridge built in winter over the cost of the same typical structure constructed in other seasons of the year. Due allowance was made for all variable and doubtful factors in carrying through this computation. The result of the analysis indicated an increase of 16½ per cent in the cost of winter construction over that of summer.

In computing this increase, consideration was given to the continued decline of construction cost that proceeded almost in a straight line from January, 1931, to June, 1932. To make the necessary allowance for this decline, the prices received on winter projects were compared with average prices for the two summers, 1931 and 1932. Analyses were made of 40 projects, twenty of the winter program and ten of each of the two summers. The costs of twelve of the principal items in these structures were carried through in detail, using as a unit price in each case the average of the three low bids. It was believed that the average of the three low bids gave a truer unit price than the lowest bid alone, which might be in some instances slightly erratic. Of the dozen items included in the study, the greatest increase in cost was noted in channel excavation, amounting to 27 per cent, followed by a 25 per cent increase for concrete bridge railing. Cost of structural steel, including its painting, was increased 4 per cent.

With the average increase in unit cost of each of the twelve principal items determined, it was necessary to know the proportion of the total cost of a typical structure which each item represented.

OIL-FLAME SALAMANDER equipped with pipe coil heats water for two-sack mixer producing more than 2,000 yd. of concrete for steel-beam bridge having four 70-ft. and two 58-ft. spans. Aggregates are heated by steam jets from movable boiler on road roller. Uncapher & Gillespie, Marion, Ohio, contractors.

To ascertain this distribution of costs for a typical structure, 44 projects were analyzed and the proportionate cost of the twelve items averaged, with the following result:

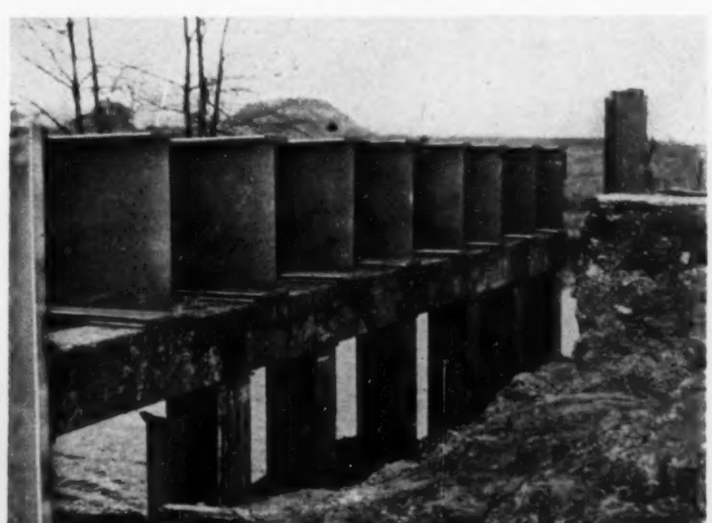
Channel excavation	7.40%
Dry excavation	2.30
Wet excavation	2.80
Timber piling	2.90
Footing concrete	10.80
Wall concrete (including piers and abutments	17.50
Superstructure concrete	15.90
Concrete railing	3.20
Reinforcing steel	8.90
Structural steel	10.80
Phosphor-bronze plates	0.35
Cast-iron scuppers	0.15
Total of twelve items	83.00%

By applying the respective unit increases to the proper items in this list, the fairly dependable figure of 16½ per cent was obtained for the increase in cost of winter work over summer work. This result is fairly representative, in the opinion of Mr. Burkey, except for one detail: a portion of the bids on 1931 summer projects were made before the state's minimum wage law went into effect. This law largely governed labor costs on the winter program and on work sold this summer.

It is interesting to note that the engineers' preliminary estimate of the increase in cost, 15 per cent, closely approximated the figure obtained by the recent analysis of the bids. The estimated 15 per cent was included in the proposals for all winter projects as a deduction for any portion of the work remaining to be done after the date set for completion.

Types of Structures—All bridges in the Ohio and Michigan winter programs were of the deck type to facilitate future widening, if necessary. Most of the bridges were concrete and steel or reinforced-concrete, although Ohio used timber bridges extensively on secondary

LIVE STEAM from perforated pipes under stockpiles heats aggregates on bridge job of Paul Nill, South Charleston, Ohio. Plank walls retain uniform depth of aggregates over steam pipes.



STEEL H-SECTION PILES form substructure of creosoted timber bridge, with I-beam stringers, constructed by George W. Timmons, of Columbus, Ohio. Timber cap rests on steel cap plates bolted to piles by angle brackets.

HAND CARTS distribute concrete for W. S. Hostler, of Mt. Blanchard, Ohio, on concrete beam bridge with two 40-ft. spans.

PLACING CANVAS INCLOSURE to protect superstructure concrete. Steam for curing will be supplied by boiler of steam shovel.

roads and at points on primary roads where future relocation was probable. Ohio also employed rolled girder beams to a great extent on both timber and concrete structures, favoring them particularly where three or more spans made continuous beams economical.

Concrete Construction—Heating and protection of concrete presented the most critical problem of winter construction and offered to the contractors the greatest opportunity for ingenuity and diversity of methods. Ohio specifications required that all concrete placed before April 1 and all concrete placed after that date when the atmospheric temperature was 50 deg. F. or below should have a temperature of at least 70 deg. F. when deposited in the forms. Suitable inclosures and heating devices were required to keep the temperature of the air surrounding the forms at 50 deg. F. or above for a period of at least 120 hr. when standard portland cement was used and 72 hr. when high-early-strength cement was used. The use of salt or chemical admixtures was prohibited.

Specifications of the Michigan state highway department for placing of winter concrete required that concrete be deposited in the forms at temperatures between 50 and 75 deg. F. and that no ingredient be heated above 120 deg. F.

OIL-FLAME INJECTOR on mixer directs hot blast inside drum to raise temperature of batch.

SECTIONAL WOOD FORMS serve Green & Sawyer, of Lima, Ohio, in building complete inclosure for concrete-beam bridge having two 30-ft. spans. Live steam heats housing at night; salamanders are used during day. Electric lights illuminate interior. Elevated hot water tank delivers to mixer by gravity.

The time to discontinue heating of protective inclosures was determined in the field by actual results of tests on concrete beams, 6x8x36 in. in size, molded at the time of placing concrete in the unit of structure which they represented and cured in the housing under the same conditions as the concrete in the structure.

Practically all of the structures were of moderate size, requiring maximum continuous concrete placements of 60 to 80 yd. Most of the contractors used 2-bag concrete mixers. The minimum mixing period was 1¼ min.

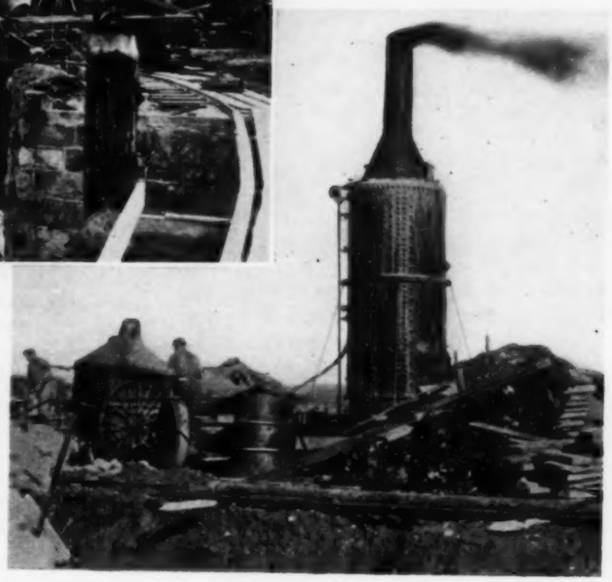
Heating Concrete Ingredients—Hot water was the essential ingredient in producing concrete of the required temperature. Water has a high specific heat, and its temperature can be raised and held within certain limits much more easily than can that of the fine or coarse aggregates. For all these ingredients of the mix, the Ohio specifications limited the maximum temperature to 150 deg. F. The limitation on the temperature of the mixing water imposed some difficulty on contractor in placing concrete in the forms at the required temperature, especially when the temperature of the air dropped to around 20 deg. F. or below.

Heat Losses—Experience on many winter jobs has shown that it is difficult to maintain a high temperature in fine or coarse aggregates until they are placed in the mixer drum. When the temperature of the air is 20 deg. F., the temperature of these materials often will not be above 50 deg. when they enter the mixer. On the Ohio projects, it was necessary that the aggregates enter the mixer at a temperature of around 75 deg. F. if the concrete when placed in the forms was to have a temperature of 70 deg. F., as will be explained in the following paragraph. It is to be understood that all these considerations relate to an atmospheric temperature of 20 deg. F.

Even when transporting concrete in masses, as was the practice on all the winter projects, the batch loses around 15 deg. by radiation between the mixer and the forms. To allow for this loss, the concrete must leave the mixer at a temperature of 85 deg. F. Tests have demonstrated that about 6 deg. of water tem-

CONCRETE PLANT *(above)* **of L. A. Davidson, contractor on Michigan winter bridge job. Placing horizontal boiler (in shed at left) on lower level permits trucks to dump directly into coal bin. Water is pumped and heated by steam ejector, and additional heat is supplied to tank on cement house by steam jet.**

PORTABLE HEATING PLANT *(below)* **on Ohio bridge contract of William A. Yeagle, Clyde, Ohio. Vertical boiler is mounted on four-wheel steel-frame trailer. Water heater (at left) is converted hand cart.**



perature is needed to raise the temperature of the concrete 1 deg. The margin of 65 deg. between the maximum specified water temperature (150 deg.) and the desired concrete temperature (85 deg.) is sufficient to raise the temperature of the batch only 11 deg. Consequently it was necessary that the aggregates enter the mixer at a temperature of around 75 deg. The water at 150 deg. then could raise the temperature of the concrete mix to around 85 deg.

Loss of heat in aggregates and in concrete depends to a certain extent on job conditions and may vary considerably on different projects. According to the judgment of engineers in southern Michigan, the estimated heat losses in the foregoing paragraphs are too high. Their experience indicates losses on the average of only about 50 per cent of those given. Based on their estimates of heat losses, the Michigan limitations on heating of concrete ingredients impose no hardship on the contractors in placing concrete in the forms at the required temperature.

A major purpose of Michigan's specifications is to assure sufficient heating of all ingredients prior to mixing, the contention being that only in this way can uniform temperatures of concrete in the forms be obtained. According to Michigan bridge engineers, it is practically impossible to obtain uniform concrete temperature by depending upon hot water to supply the necessary heat, and variation in the concrete temperature may produce shrinkage cracks.

Heating Water—Of the various methods of heating water, the most popular and the simplest was a steam jet in an open water tank, of 50- to 100-gal. capacity, which delivered by gravity to the tank on the mixer. The jet usually consisted of a 1- or $1\frac{1}{2}$-in. pipe with the open end placed within a few inches of the bottom of the tank. Where possible, the steam line to the jet was equipped with a valve at the mixer for easy control by the mixer operator. This method of heating water was quick in its effect, was easily controlled, and was fairly economical in steam consumption.

Ranking second in favor among the contractors on winter projects as a method of heating water was the oil-burning or coal-burning salamander containing a water coil. The oil-burning water heaters were usually products of commercial manufacture, but the coal-burning salamanders in general were made by the contractors. This type of heater performed satisfactorily under most conditions, but when the atmospheric temperature was low and concrete was being placed rapidly, it was necessary to force the equipment to provide sufficient hot water. On several projects, the contractors added auxiliary heating devices, particularly where coal-burning salamanders were used, to keep the hot water supply at the required temperature.

Because of the small size of the projects, steam coils in the water tank were little used for heating water. This method has proved effective on large projects requiring tanks having capacities of several thousand gallons, but its use on small jobs was usually regarded as uneconomical because of the large tank required for its efficient application.

Steam siphons (ejectors) were employed in a few cases to pump water directly from the stream at the bridge site. The steam siphons both heated the water and pumped it to the tank. On one job in Michigan where this equipment was used, the contractor also employed a steam jet to increase and control the temperature of the water in the tank.

Heating Aggregates—Although aggregates have a low specific heat, they take the heat slowly when stored in stock piles. Aggregates heated to more than

STEAM JETS connected by hose to boiler heat sand and gravel. Jets are inserted in stock pile at point from which material is being taken.

WATER HEATER and hot water tank on Ohio bridge job of Wertz Co., Cleveland. Pipe coils in salamander are heated by coal fire.

BOX CULVERT is housed in canvas and heated by salamanders. Davis & Davenport, Spencerville, Ohio, contractors.

100 deg. F. in the stock piles lose this heat rapidly during transfer to the mixer and rarely get into the drum at a temperature above 60 deg. F. Wheelbarrows were used on practically all the winter projects to transport the aggregates from the stock piles to the mixer. Coarse aggregates included gravel, crushed rock and crushed slag.

Grills of perforated steam pipes under the stock piles were the most common and most satisfactory means of heating aggregates. The grills were rectangular in plan and consisted of 1½-in. pipes spaced 2 to 4 ft. apart, with ⅛-in. to ¼-in. holes at 12- to 18-in. intervals along the pipes. Holes ⅛ to $\frac{3}{16}$ in. in diameter were preferred, as larger holes were likely to become plugged by sand. Stock piles usually were spread to a uniform depth of about 4 ft. over the pipes, wood plank walls often being constructed to form bins for this purpose. The success of this heating method depended upon using a boiler of sufficient capacity and upon heating the material for a sufficient length of time before starting to mix concrete. Stock piles always were covered with canvas tarpaulins or building paper to retain the heat. A 25-hp. boiler operating at 35-lb. steam pressure was capable of heating aggregates and water for a concrete volume of 80 yd. The period required for preheating the aggregates varied from 12 to 24 hr., depending upon the atmospheric temperature.

Experience in Michigan has shown that a 35-hp. boiler can easily heat aggregates for 80 yd. of concrete in extremely cold weather to 90 deg. F. in a maximum period of 24 hr. and can also supply steam to heat mixing water and housing while concrete is being placed. If a temperature of 90 deg. F. is attained uniformly throughout the pile before mixing starts, it is possible with a boiler of this capacity to maintain the temperature through the day, provided the stock pile covering is removed as the material is used. A boiler of this size frequently supplies steam to heat a second housing at the same time.

By maintaining a fairly even temperature of 90 deg. F. in the stockpiles, a constant temperature of water can be employed to produce concrete of uniformly high temperature. Flow of water and steam to the hot water tank is regulated to deliver water of the desired constant temperature to the mixer.

Steam jets were used successfully on a number of Ohio projects to heat the aggregates. The jets consisted of 1- or 1½-in. pipes about 6 ft. long, closed at one end and connected to a steam hose at the other. Each jet pipe was perforated with $\frac{3}{16}$- to ¼-in. holes about 1 ft. apart. The outstanding advantage of the steam jet was that it could be applied directly to the portion of the stock pile from which material was being taken. Its efficiency at low temperature is open to question, but at temperatures of 25 deg. F. or above, the method worked satisfactorily. Under fairly mild conditions, many contractors used steam jets to heat the sand only and relied upon the water to raise the temperature of the coarse aggregates in the mixer. Sand, partly because of its moisture content, takes the heat more readily and retains it better than does a coarse material.

Michigan engineers permitted use of steam jets if the heating was skillfully done to produce a uniform temperature throughout the aggregates before mixing started. Experience in that state, however, has shown that it is almost impossible to obtain this uniform heating of aggregates for a large volume of concrete by means of jets, and the method was not encouraged on Michigan bridge projects.

A third method of heating aggregate, which found little favor with either contractors or engineers, employed wood-burning or coal-burning furnaces in the stock piles. The furnace consisted of large-diameter metal pipe passing through the bottom of the pile. This method required continuous shoveling of the material and constant watching to see that the aggregates were not damaged by overheating.

Mixer Heaters—Oil flame injectors mounted on the mixer frame to direct a hot blast inside the drum were employed to a limited extent on Ohio projects to repair loss of temperature in the ingredients of the mix. Several contractors in mild weather dispensed altogether with the heating of aggregates and relied upon hot water and a mixer heater to produce the required temperature in the concrete. Engineers of the Ohio department of highways expressed no objection to the use of oil flame injectors, provided combustion was perfect. If imperfect combustion was obtained, they feared that some oil might enter the mix. Oil flame injectors have been known to raise the temperature of a batch in the mixer drum 10 deg. F. in 1½ min. Mixer heaters are not used on state bridge work in Michigan.

Housing—Inclosures to protect the concrete while it was curing were erected with sufficient clearance around the structure to permit men to work inside the housing. Most contractors used canvas tarpaulins erected on wood staging to enclose the concrete structures. Build-

WOOD-SHEATHED INCLOSURE *(left)* protects abutment of bridge built by Meredith & Haynes, of Detroit, for Michigan state highway department. Two steam pipes around walls inside are equipped with petcocks to release live steam. Stockpiles (in right background) are heated by grill of perforated pipes.

TRUCK MIXER *(right)*, loaded with hot aggregates and hot water at commercial batching plant, mixes concrete at bridge site, on Ohio contract of J. H. Berkebile & Sons.

ing paper or roofing paper on timber frames made a satisfactory inclosure on a number of jobs. Wood-sheathed housing proved serviceable on several projects, but its higher cost prevented wide use of this type of inclosure.

Curing Concrete—During the curing process, the concrete had to be kept warm and moist. Steam lines inside the housing were the most satisfactory means of providing this double service, as they both maintained the required temperature and released live steam to furnish the necessary moisture. The steam pipes were equipped with valves or petcocks or were laid with loose joints to release the steam. In rare cases on Ohio projects, where the inclosures were extremely tight, workmen were unable to strip the forms and rub the concrete in an atmosphere filled with live steam. In these instances, some other heating method, such as stoves, had to be used while work was being performed inside the housing.

For the last 3 years, the Michigan state highway department has required steam lines and boilers for heating winter concrete, as this method offered the only practicable means of maintaining a uniform moisture content inside the housing while stripping forms and rubbing concrete. Several contractors last winter successfully used discarded building radiators equipped with petcocks in heating housing.

Oil-burning or coke-burning salamanders, equipped with chimneys to conduct the fumes outside the housing, proved effective in heating the concrete inclosures on many Ohio jobs. The salamanders, however, dried the air inside the housing and made it necessary to cover the concrete with wet burlap after the forms had been stripped. Where no chimneys were used with the salamanders, it was impossible for workmen to remain inside the housing, and fresh air had to be admitted during the stripping and finishing operations.

Side forms were stripped as soon as the concrete had obtained sufficient strength, usually on the day after it had been placed. Rubbing of exposed surfaces began immediately.

Distributing Concrete—Concrete was transported from the mixer to the forms in buggies, buckets, or tip-over cars on narrow-gage track. By moving the concrete in masses, the loss of heat was kept at a minimum. On jobs where footing concrete had to be placed by means of chutes or spouts, the batch was heated to a higher temperature in the mixer to make allowance for the heat loss occasioned by this method.

CANVAS HOUSING completely incloses superstructure of Ohio bridge built by Melvin L. Jones. Sufficient clearance is provided to permit workmen to distribute concrete in wheelbarrows under canvas.

Timber Bridges—Ohio built a large number of structures which were classed as timber bridges, although steel I-beams generally were used as stringers and the substructure occasionally consisted of steel H-section piles. All timber used in the superstructure and substructure of these bridges was creosoted.

Because of the short time available in which to order and obtain delivery of creosoted timber for its winter program, the Ohio department of highways took bids for the creosoted lumber and piles to be supplied to all bridges and divided the order for the entire state between two companies. These companies contracted to fabricate and creosote the lumber and piling for a structure immediately upon receipt of plans and to deliver the material to the point designated in the contract, either to the bridge or to the nearest railroad siding. As green timber necessarily had to be used, the companies seasoned it artificially by boiling in a vacuum.

Both types of substructure for timber bridges are illustrated by the accompanying photographs. In the case of the steel substructure shown, 12x10-in. H-section piles, 30 and 35 ft. long, weighing 53 lb. per foot, were driven to grade with a drop hammer. Steel cap plates were bolted to the piles by angle brackets, the holes used to attach the brackets to the piles being drilled in the field to make sure that the plates would be at a uniform level. A timber cap was placed on these cap plates, and steel bearing plates were installed on top of the timber cap to carry the I-beam stringers.

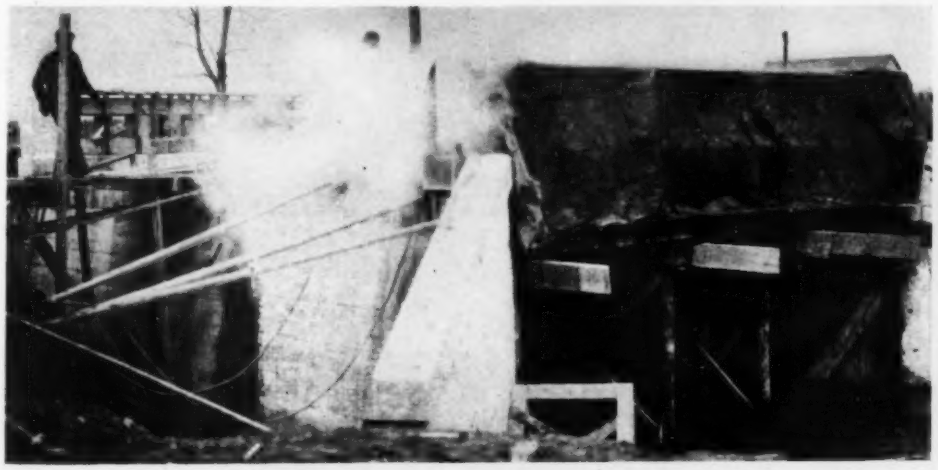
On the wood-pile bridge, the timber cap was strapped to the piles, as shown by one of the photographs, and steel bearing plates were bolted to the timber cap. The stringers were welded to the bearing plates.

Creosoted 6-in. oak strip flooring, used on all timber bridges, was attached to the upper flanges of the steel stringers by cleats placed on 1-ft. centers on opposite sides of the beams. A bituminous mat wearing surface was laid on the oak strip floor.

Quality of Work—Mr. Burkey and the other engineers of the Ohio department of highways are well satisfied with the quality of work obtained in the winter contracts. They believe it is in all respects equal to that ordinarily obtained under more favorable weather conditions.

Administration—In Ohio, the bridge program was directed by J. R. Burkey, chief engineer of bridges, assisted by W. H. Rabe, chief designing engineer of bridges, W. G. Smith, field bridge engineer, C. L. Moyer, planning engineer, and Elmer Hilty, chief engineer of construction. These men acted under O. W. Merrell, director of highways, and H. P. Chapman, chief engineer of the department.

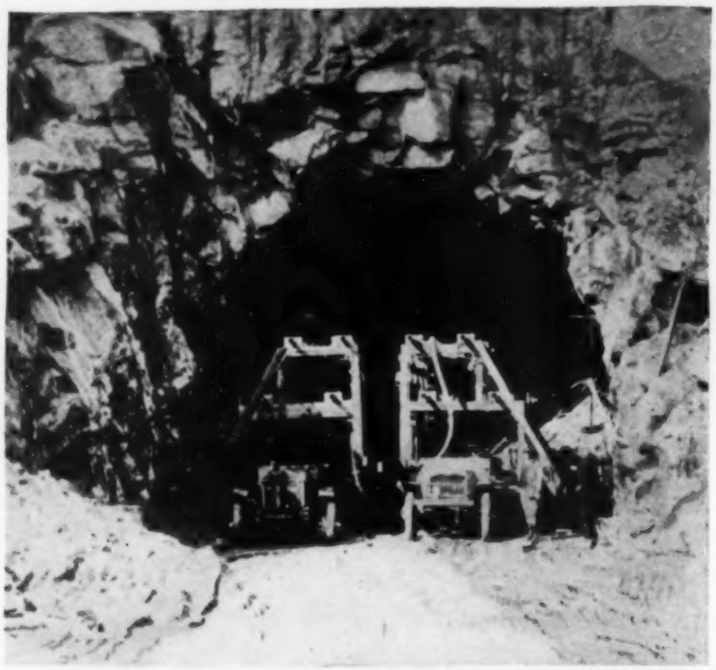
Michigan's winter construction program was directed by G. C. Dillman, state highway commissioner, and Clifford E. Foster, chief engineer, with C. A. Melick, bridge engineer, in charge of all bridge projects.



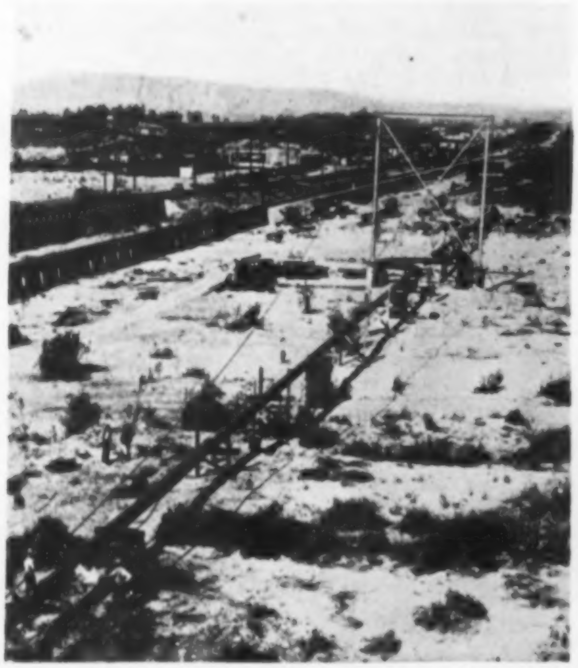
CONCRETE BRIDGE RAIL is covered with canvas and cured by steam delivered through hose lines from old threshing-machine boiler. V. H. Mertz, St. Johns, Ohio, contractor.

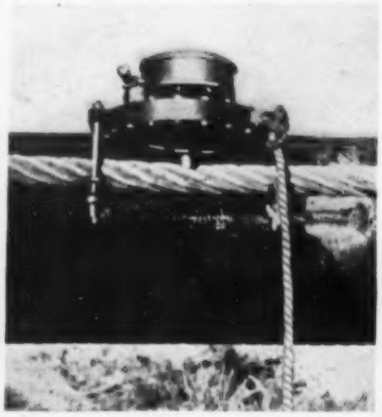
Getting Down to
DETAILS

Close-up Shots of Job Methods and Equipment



DRILL CARRIAGES *(above and below)*, mounted on motor trucks, used by Northern States Construction Co., in driving Swift River tunnel for Metropolitan Water Supply Commission of Massachusetts. Tunnel section is 28 ft. high and 30 ft. wide. Each carriage has three cross-bars supporting five drifter drills. Carriage frame is sloped on one side to fit curve of top heading.





TENSION INDICATOR aids adjustment of 2-in. diameter steel cables on 360-ft. suspension span *(above)* carrying 20-in. natural gas pipe line over dry wash in southern California. Equalizing of cable stress on two sides of supporting tower to calculated load of 73,000 lb. was accomplished by use of Martin-Decker heavy duty tension indicator *(above, right)* applied to cables near their anchorages. With this device loads on either side of tower were balanced without changing anchorage attachment.

FOR REAMING HEAVY CHORD MEMBERS of steel trusses used for the new union railroad station in Cincinnati, Ohio, special power tools were devised by the fabricator, The R. C. Mahon Co., of Detroit. To insure accurate alignment of rivet holes, the steel truss members were assembled at the fabricator's yard and reamed with radial drills and special power-driven reamers. The heaviest sections require 1¼-in. rivets with a 7-in. grip. Illustration shows web being reamed by machines riding on chord and *(at left)* traveling reamer at work on holes in cover plate. Steel erection for the new station was done by the Bass Construction Co., of Cleveland, as subcontractor for James Stewart & Co., general contractor, of New York.

Present and Accounted For—

A Page of Personalities

Devoted this month mainly to a few of the supervising field engineers, contractors and project engineers who aided in the successful execution of Ohio's and Michigan's winter bridge construction programs, described elsewhere in this issue

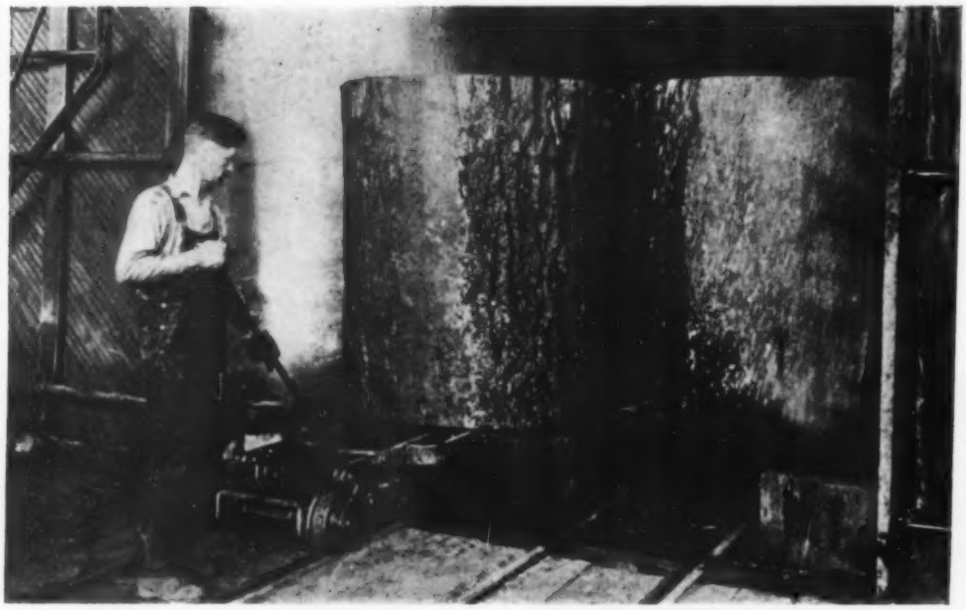
LT. COMMANDER HOMER N. WALLIN and LT. HENRY A. SCHADE, U.S.N., members of construction corps at Mare Island Navy Yard, Calif., win $7,500 first prize in Lincoln Electric Co. arc-welding competition. Winning paper describes construction of arc-welded naval auxiliary vessel 118 ft. long with full load displacement of 300 tons. About 400 papers were submitted in competition, and jury awarded 41 prizes.

LINED UP ALONG RAIL of Ohio bridge which they are replacing. *(Left to right)* WILBUR SEEDS and J. I. OBERLANDER, assistant engineers, Division 6; CHARLES GILLESPIE, of Uncapher & Gillespie, contractors; J. E. MARTIN, inspector; and HARRY H. HAWLEY, assistant engineer of construction, Ohio department of highways.

ON OHIO PROJECTS. *(Left to right)* C. R. HANES, assistant division engineer, Division 1; W. S. HINDMAN, special bridge engineer, Ohio department of highways; and W. S. HOSTLER, contractor. *(In center of page)* C. RAY SYKES, division bridge engineer, Division 7.

IN MICHIGAN. *(Left to right)* C. L. COWGILL, resident construction engineer; L. A. DAVIDSON, contractor; and C. C. JOHNSON, project engineer.

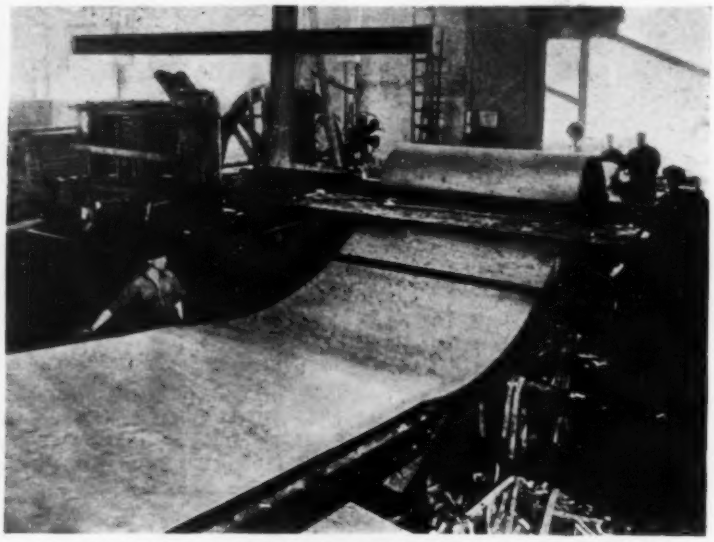
Step-by-Step
How Plywood Panels Made From



IN ORDER to build watertight forms, to produce smooth concrete surfaces without board marks or "fins," and to facilitate the operation of stripping, many contractors have adopted the practice of using Douglas fir plywood, either as form lumber or as lining for wood forms. This material, consisting of three or more thin laminated sheets, glued together, cross-grain, under hydraulic pressure to pre-

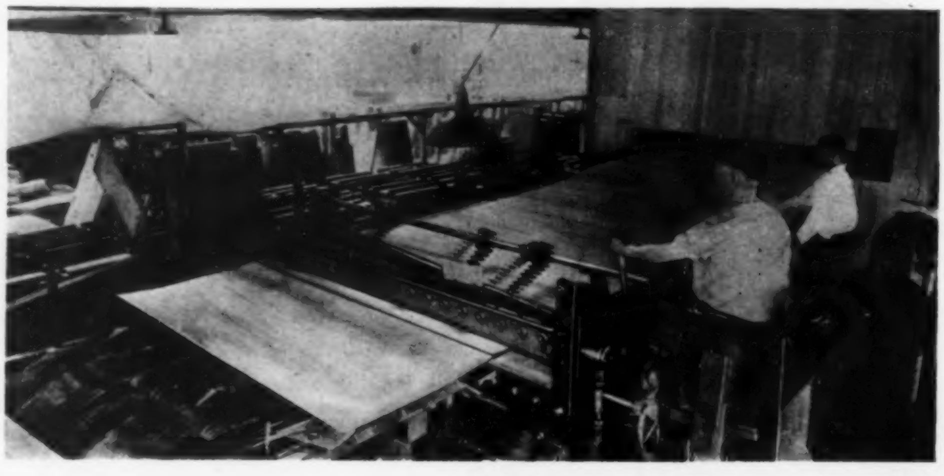
1 LOGS *(left)* of Douglas Fir, cut to required lengths are first placed in a steam chamber. During steaming period of from 48 to 72 hr., grain is softened, bark loosened and resin driven off.

2 BARK is removed from the steamed logs before they are sent to the lathe.



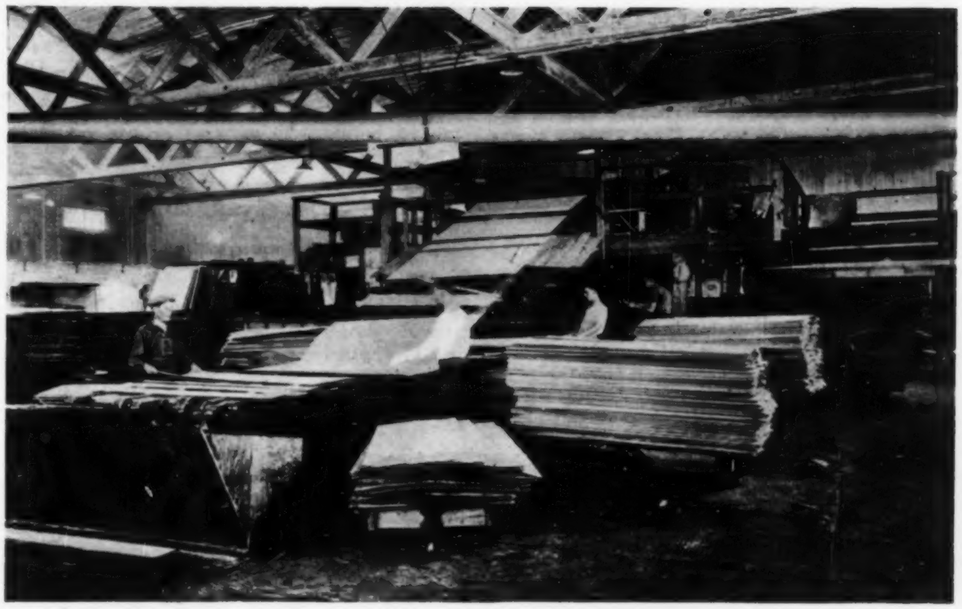
3 MOUNTED IN LARGE LATHE the log is "unwound" by cutting continuous sheet of veneer of whatever thickness is desired. The lathe will hold logs up to 8 ft. in diameter and 10 ft. long.

4 CLIPPING *(right)* is done by machine operators who cut continuous sheet of veneer into as many wide, clear sheets as possible, depending upon sizes wanted in production.

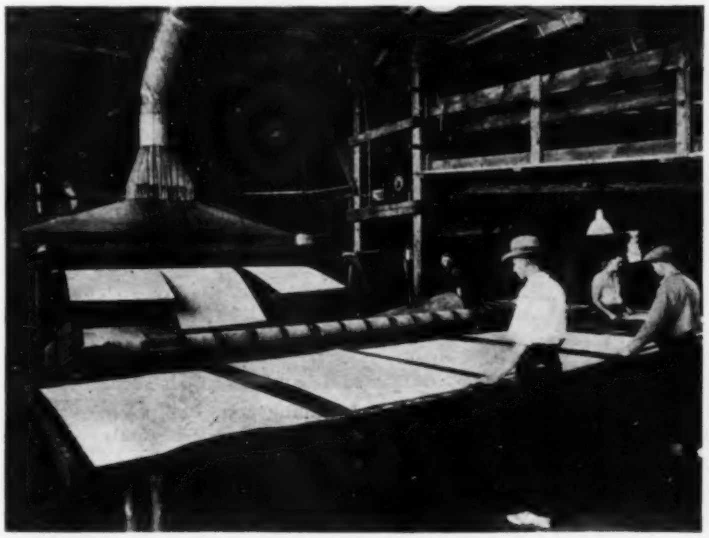


Production Methods for Concrete Forms Are Douglas Fir

vent warping, is produced in stock sizes up to 4x8 ft. and in thicknesses generally of ⅜ and ¼ in. for construction use. The process of manufacture, starting with a log which is mounted in a huge lathe and "peeled" off into a thin wooden sheet of the desired width, involves special methods and equipment which have been developed by the Douglas Fir Plywood Manufacturers, of Seattle, Wash., the source of the accompanying series of photographs.



5 SORTING *(right)* is done on table where sheets cut by clipper receive a preliminary grading.

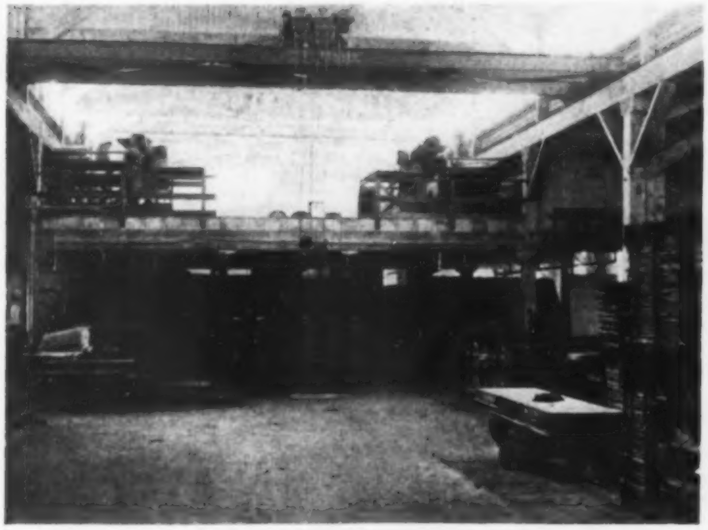


6 DRYING. Depending on its thickness, each sheet of veneer is dried out to a predetermined moisture content.

7 READY FOR GLUING. Sheets of face veneer are examined for defects and piled in pairs, one sheet with smooth side up and other sheet with smooth side down, preparatory to assembly at glue spreader.

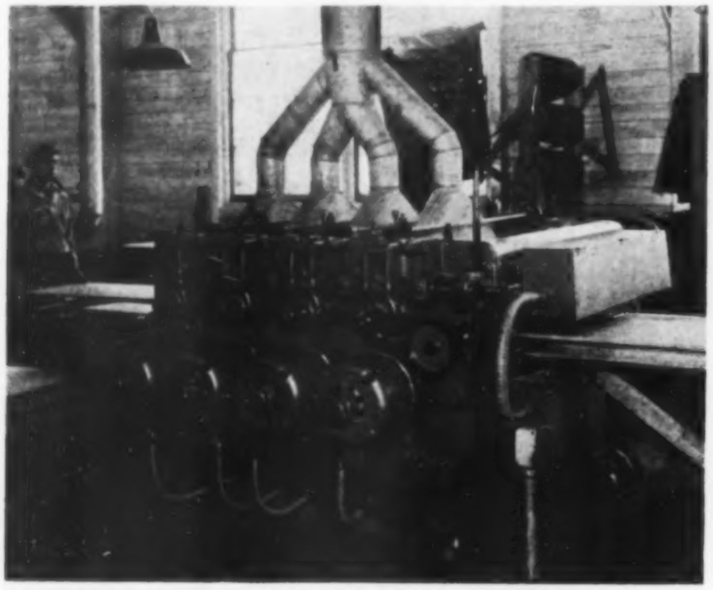
8 GLUING *(left)*. Spreader applies glue to both sides of core in making three-ply stock. Operators fit glued stock tightly together between veneer sheets to which no glue has been applied, thus assembling panel. For five-ply and thicker panels the core is not glue-filmed, but the cross banding receives the glue.

Continued on next page

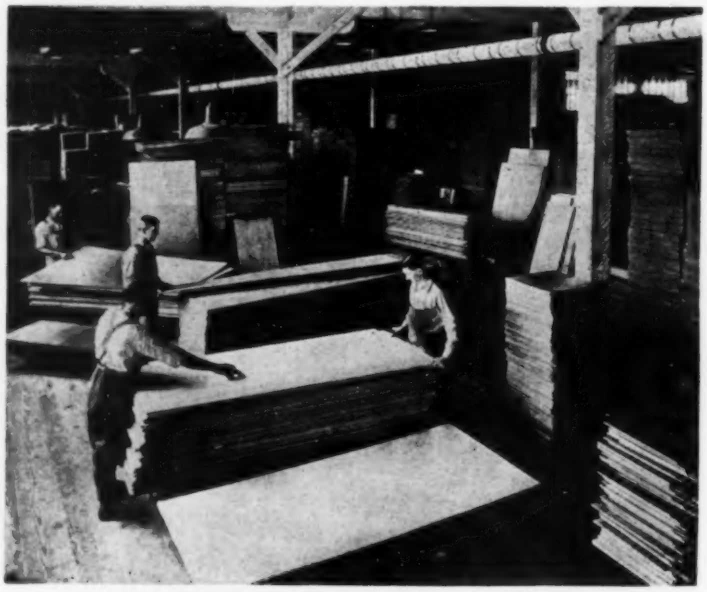


9 PRESSING. In background is a package of 50 panels leaving the 400-ton hydraulic press. Pressure is applied and maintained for 24 hr.

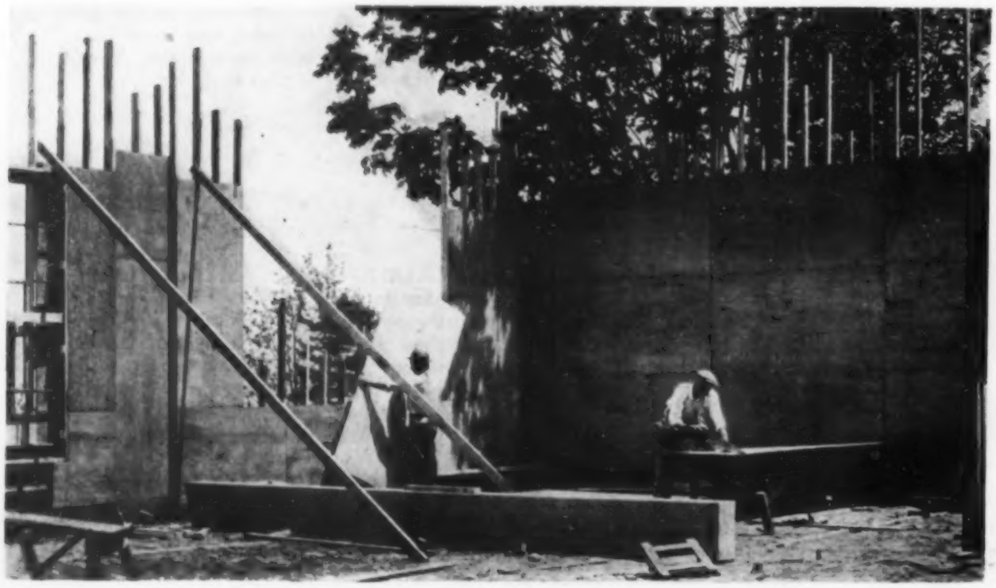
10 TRIMMING. After pressing, the panels are ready for trimming to standard or special sizes.



11 SANDING. An eight-drum, double-deck sander with each drum driven by an individual motor produces a finish of satin smoothness for all Douglas Fir plywood, unless specially ordered otherwise.



12 LAST INSPECTION and grading before shipment to insure uniform quality of the plywood panels.

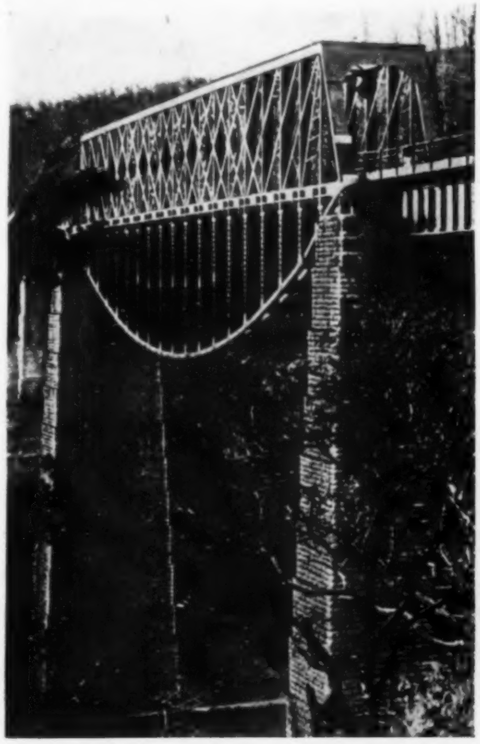


13 FORMS *(left)* for concrete walls of Hill Military Academy building, at Portland, Ore., are made of $\frac{5}{8}$-in. Douglas Fir plywood in 4x8-ft. panels. The contractor on this job was the Austin Co., of Cleveland.

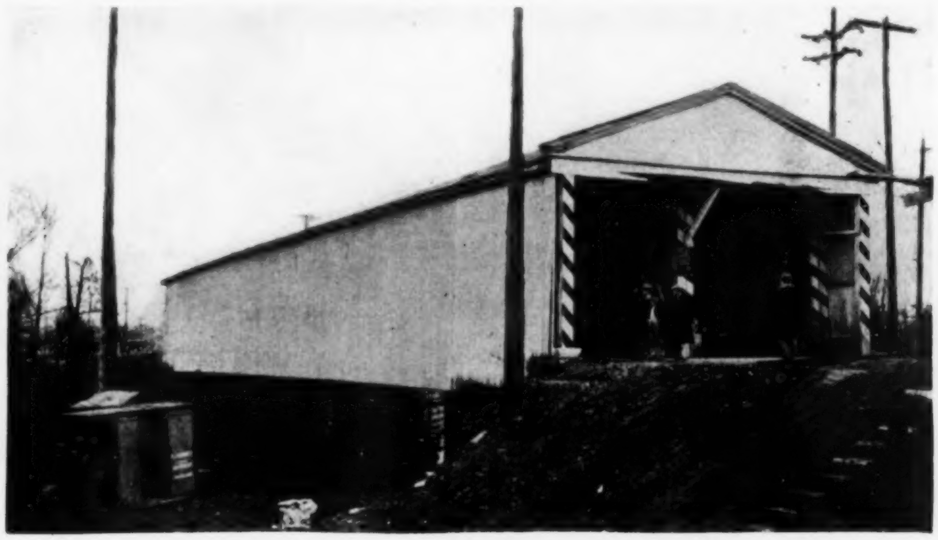
JOB ODDITIES

A Monthly Page of Unusual Features of Construction

STEEL CHECK for $7,500 with all writing done by arc-welding, was presented by Lincoln Electric Co., of Cleveland, Ohio, to Lieut.-Commander Homer N. Wallin and Lieut. Henry A. Schade, winners of contest for best paper on application of electric welding.

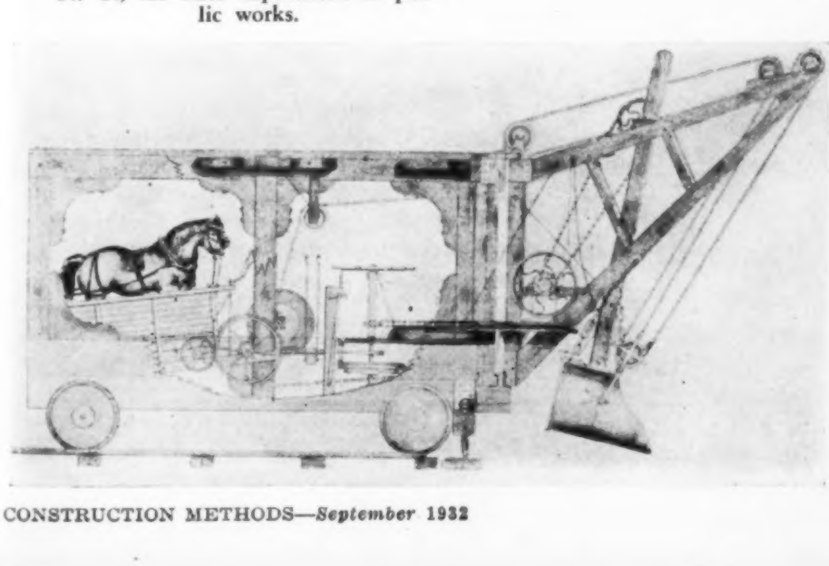


UNDERHUNG BOWSTRING, with only vertical struts and no diagonal members, strengthens 250-ft. through-truss Dhorabhavi bridge on Madras & Southern Mahratta Railway in India.

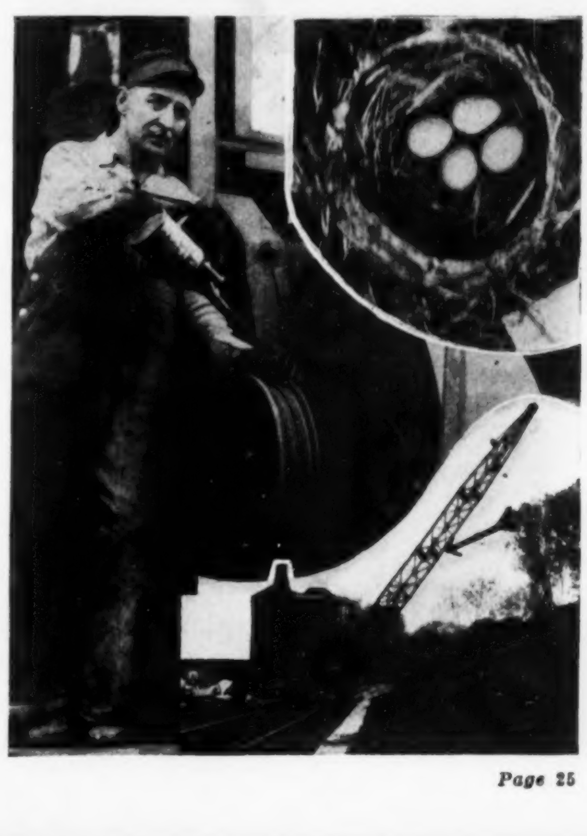


LAST TIMBER BRIDGE on National Road (U. S. 40) in Ohio is replaced by three-span concrete bridge with steel beams, built by Ross Construction Co., of Columbus. Project is included in state's winter construction program, described elsewhere in this issue.

REAL HORSE POWER *(below)* drives this shovel. Old print, dated 1852, illustrates "land excavator" developed by J. C. Osgood, of Troy, N. Y. Illustration received from Guy W. Pinck, district engineer at Troy, N. Y., for state department of public works.



BIRD'S NEST IN BOOM *(right)*. Robins establish residence in Link-Belt steam-operated locomotive crane used daily to handle coal at waterworks pumping station in Omaha, Neb.



INCLINED SHAFT *Aids Driving of C. & O. Railway Tunnel*

Approach cut at portals involves large rock yardage—Scaffold car handles concrete for lining behind steel forms

Fourth of a series of articles on mainline tunnel improvements by the Chesapeake & Ohio Railway

EARLY STAGE of the east approach cut showing proximity to existing main-line tracks.

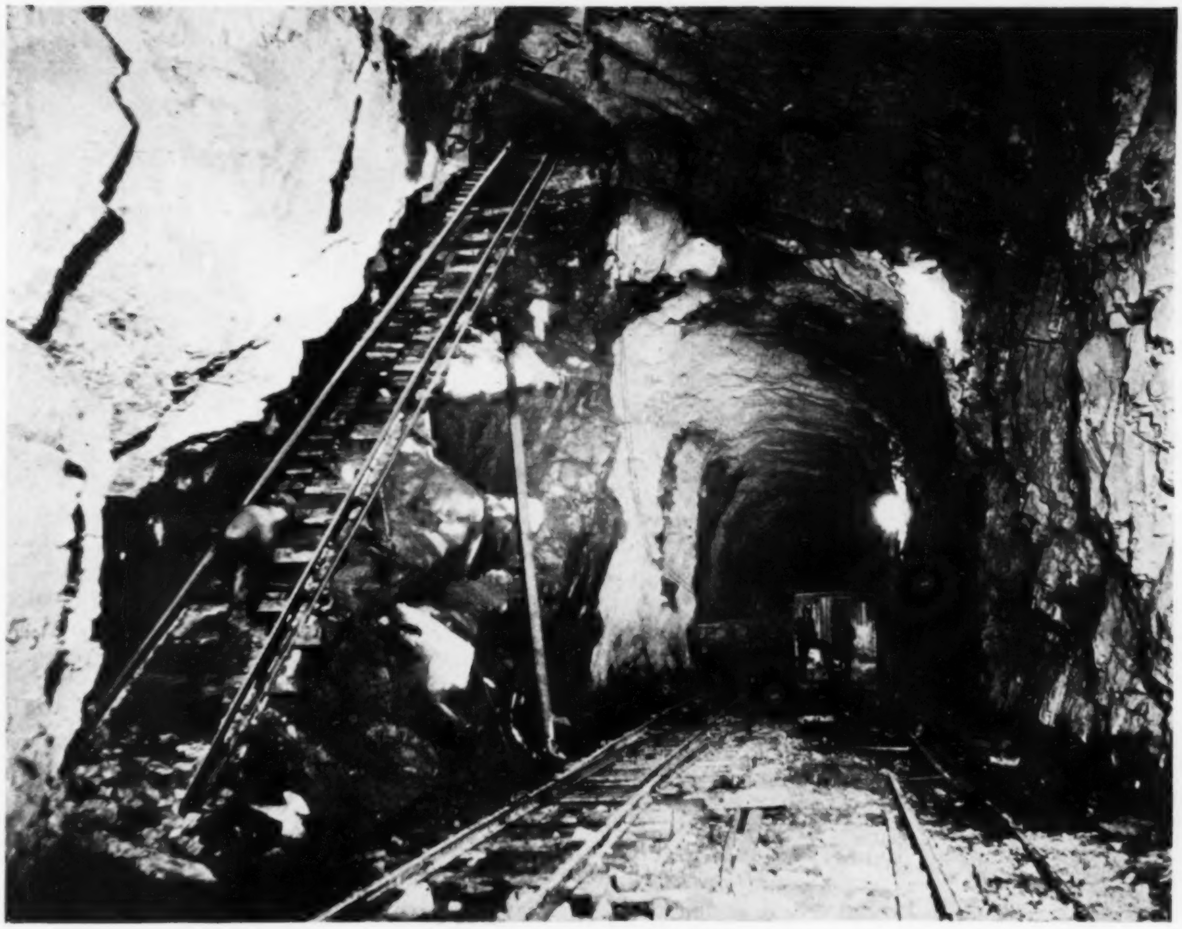
ONE of the most important among the numerous large projects involved in the extensive betterment program which the Chesapeake & Ohio Railway has under way through the mountains of Virginia and West Virginia is the construction of a single-track tunnel, 3,061 ft. long, paralleling on 70-ft. centers the existing Lewis tunnel just east of the summit of the Allegheny Mountains. An approach cut of 336,000 cu.yd. to the east portal and one of 276,000 cu.yd. to the west portal, together with about 67,000 cu.yd. of tunnel excavation, bring the total of the material to be moved on this job to more than 679,000 cu.yd. Most of this material has been a dense sandstone of peculiar toughness.

HORIZONTAL BAR SET-UP of group of four drills used in making blast holes made to loosen bench of tunnel excavation in single lift. Top of bench is about 2 ft. above top of ladder.

In order to meet various local conditions the Bates & Rogers Construction Co., general contractors for the tunnel and the two approach cuts, adopted methods of driving the tunnel headings that were quite out of the ordinary. In placing the 20,000 cu.yd. of concrete required in lining the tunnel they also used a system of forms and methods of handling the concrete from the mixer to place, that much simplified this feature of the project.

On account of the large quantities of material that had to be moved from the approach cuts before the portals could be reached, the decision was made to drive the headings for the tunnel in both directions from the foot of an inclined shaft sunk about midway in the length of the tunnel. At the mouth of this shaft the cover over the tunnel is about 130 ft. Nearby is a ravine in which the spoil could be wasted conveniently.

The shaft, with a cross-section of approximately 9x12 ft., was sunk at an angle of 33 deg. with the horizontal.



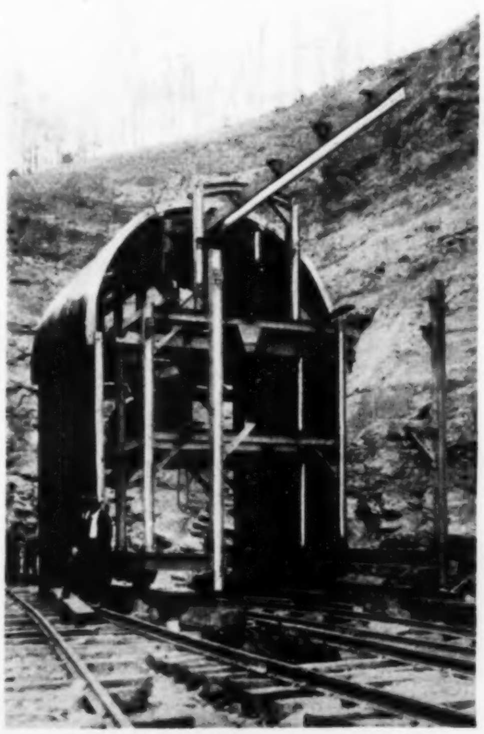
FOOT of incline up which all spoil from tunnel headings was drawn in cars operating on track shown at left.

The location also brought the foot of the shaft in at one side of the tunnel bore, leaving the roof of the latter intact.

A 36-in. gage track was laid in the shaft so the spoil could be drawn to the surface in cars by a hoist. These cars were handled between the foot of the shaft and the working faces of the headings by a storage battery locomotive. On the surface they were shifted to the dump and back by a gasoline locomotive.

Both headings were driven to take out the arch section of the tunnel excavation down to 1 ft. above the springing lines, with a height of 9 ft. at the center line and a normal width of 20 ft. at the bottom. Drilling, shooting and mucking were done alternately in the two headings. As soon as a round of holes was drilled in one heading the equipment was all loaded on a double-truck flat car and shifted to the other heading. Then the holes in the first heading were fired and the spoil from the shot was mucked while the second heading was being drilled.

Shifting of the drilling equipment was carried out according to a carefully organized routine that reduced this feature of the operations to a regular sequence of loading, unloading, setting up and dismantling. The equipment was placed on the car in the reverse order in which it was to be set up. Nothing had to be put to one side or handled twice. The actual shift from one heading to the other with the locomotive was a matter of a few minutes.



SCAFFOLD CAR and section of steel tunnel forms being erected near west portal. Arch ring of form shown partly telescoped down over sidewalls to permit section to enter tunnel and to pass through another section of form.

Spoil from the headings was mucked by hand, since it was impractical to get a power shovel down the shaft. The amount of labor required for mucking was reduced much by the use of steel-plate shoveling sections laid the full width of the floor and extending back 30 ft. from the working face. Two-way 2-yd. dump cars with the lip of the bodies only 36 in. above the floor were used for shifting the spoil from the headings to the surface dump. This height permitted the shovelers to load the spoil with very little lift.

Three pairs of cars were sufficient to keep the mucking going without delay. One pair was at the working face, one en-route and one at the dump. When the shift was made from one heading to the other the same set of cars went over.

Ventilation presented an entirely different problem from that involved when headings are driven from portals. To provide ample fresh air a 22-in. motor-driven exhaust fan was set near the mouth of the shaft, with an 18-in. steel duct leading to the bottom of the latter. Each heading was served by a 16-in. branch exending to the working face. With this set-up running nor-

mally, good air conditions were easily maintained in the headings. Fumes could be cleared quickly after shots were fired. By means of valves the fan was arranged so it would force fresh air into the heading or withdraw foul air as desired.

After the headings had been holed through from the base of the shaft to the two portals, the removal of the remainder of the tunnel excavation core was started at the west portal. It was necessary to handle all of the bench removal from that portal since the east approach cut had not been finished.

With the headings driven, the remainder of the section to be taken out was theoretically 18.5 ft. high and 20 ft. wide, with vertical sides. This entire bench, running from 12 to 16 cu.yd. of material to the linear foot of tunnel, depending on the overbreak, was drilled, shot and mucked as one operation, instead of the usual scheme of two benches.

Some experimenting was done in the beginning with the usual two-bench type of drilling and shooting. On account of the heavy charges necessary in the unusually tough sandstone, rock would be thrown 200 to 300 ft. from the face with each shot. The single bench eliminated this almost entirely, saving the mucking crew an hour or more daily. This method also permitted the use of a power shovel to advantage, producing a clean, high muck pile on which the shovel could start immediately after the shot. It further reduced considerably the amount of drilling and powder required per cubic yard of rock removed.

On the single bench the entire drilling operation was performed with four heavy water-cooled Leyner-type air drills all mounted on a horizontal bar. Only one set-up of the bar, 4 ft. above subgrade, was made for each round of holes. Several trials were made using five, four and three drills and a corresponding number of rows of holes. The four-drill set-up worked out as the most economical and effective.

In starting a round of holes 3-ft. steel was used. Because of the hard and abrasive character of the sandstone, a bit would become so dull and lose so much gage that it could be used only to a depth of 2 ft. before it had to be sharpened. So the bits were increased in length by 2-ft. increments up to the maximum of 21 ft. required. The average length of the bench pulled per round was 17 ft.

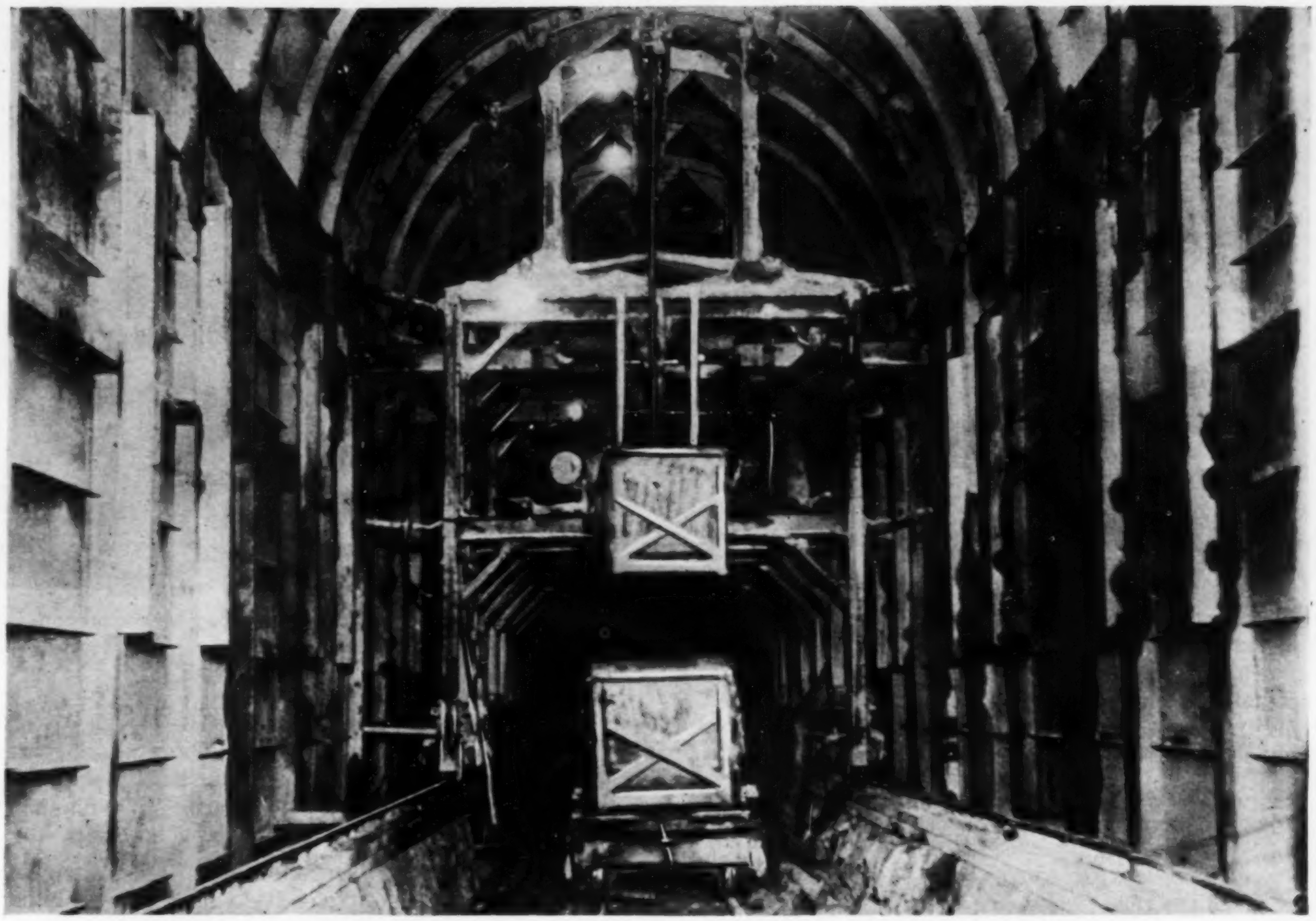
All concrete for the tunnel lining was mixed in a plant set up in the west approach cut about 400 ft. from that portal. Materials were delivered in standard-gage cars on an adjacent siding and handled either to stock piles or to a hopper over the mixer by a locomotive crane.

The floor of the tunnel is paved with a 6-in. slab 10 ft. wide under the permanent track ballast. At both edges of this slab is a retaining wall, 24 in. high, to hold the ballast in place and to form, with the adjacent footing of the sidewall of the tunnel, a concrete floored drainage ditch. The sidewalls and the arch have a minimum thickness of 12 in. inside the neat lines of the excavation.

The scheme of operations on the lining was first to pour the footing courses of the sidewalls, the two drainage ditches and the two ballast walls ahead for a distance of 300 ft. The steel forms used in placing the lining could then be erected accurately to line and grade on the ballast walls.

The steel forms were built in sections 30 ft. long, each section consisting of the sidewalls and arch ring of that length. Two sections of forms were provided, each being independent but the design of both being duplicate. Each section, weighing 18 tons, was

MIXING PLANT near west portal which furnished concrete for lining tunnel. Concrete was shifted from this plant to pouring point in tunnel in buckets on flat cars.



SCAFFOLD CAR IN PLACE under section of steel tunnel form. Hoist on car is lifting 1-yd. controllable dump bucket in which concrete was brought to forms from mixing plant on flat cars. Scaffold car provides clearance for tunnel spoil trains to run under it.

first erected outside and then shifted to its first position in the tunnel by means of a special traveler or scaffold car.

Concrete was shifted from the mixing plant to the point where pouring was in progress in 1-yd. controllable bottom-dump buckets handled on flat cars by a gasoline locomotive. The scaffold car was equipped with a trolley on an overhead track that cantilevered out at one end so the buckets could be lifted from the cars and raised to dump into a hopper on the scaffold car. From this hopper the concrete flowed by gravity into the sidewalls of the forms. The arch concrete was placed by a pneumatic outfit fed from the same hopper on the scaffold car.

Design of the steel form sections was such that they were practically self-supporting when blocked in position for a pour. When concrete was being placed, the scaffold car was set under the form in use. Heavy trench jacks on the car frame were then set against the form at definite points in the arch and sidewalls to brace the forms thoroughly and to hold them to perfect alignment. Concrete was then poured in such manner as to bring the sidewalls and the arch ring up at the same rate on both sides.

When one section of form was filled, the next section was run in ahead of it and placed and filled. A 30-ft. section was poured each 36 hr. The night shift released the jacks on the scaffold car, moved the latter back under the section previously filled, lowered that form so it rested on the scaffold car and then moved it ahead to be set up for the next day's pour.

When working normally, a section of form could be drawn, shifted ahead and reset in the new position in about 6 hr. with 8 men. Usually the concrete in a section of form was placed in from 7 to 10 hr. Once pouring of a section was started it was continued until that section was filled.

Concrete lining operations were not begun until the bench excavation had been advanced 1,600 ft. from the west portal, which was beyond the shaft. After that concreting and excavating were carried on simultaneously without interference. The scaffold car was built so the trains of 5-yd. dump cars in which the tunnel spoil was handled could run under it with ample clearance.

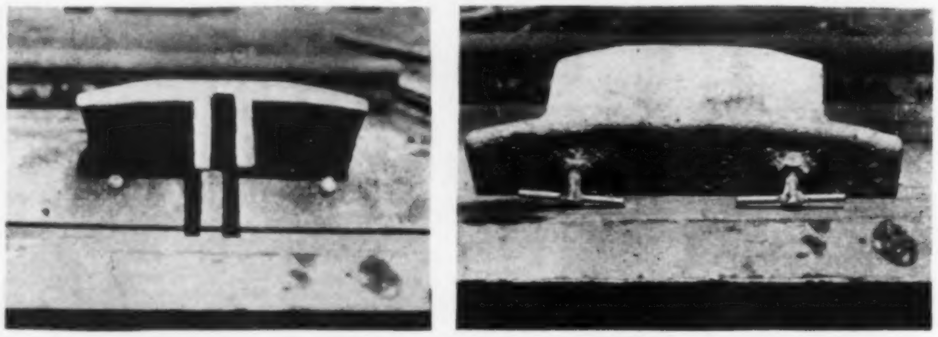
C. W. Johns is chief engineer of the Chesapeake & Ohio Railway, E. G. Rice is engineer of the district in which this project is located, and F. G. Cobb is resident engineer directly in charge.

L. C. Rogers, district manager of the Bates & Rogers Construction Co. at Cleveland, Ohio, directed the work for that organization.

NEW CONSTRUCTION KINKS

Improve California Paving

GREATER economy and efficiency in the costruction of high class pavements, accompanied by greater speed in production, were achieved last year in California by the State Department of Public Works. Through the initiative and efforts of the state's highway engineers, new methods and improved equipment were suggested and developed, resulting in higher yardage records, better mixes and smoother surfaces. The accompanying notes and illustrations of details which have been responsible in large measure for the improved results obtained are from a report by Earl Withycombe, assistant construction engineer, Division of Highways.



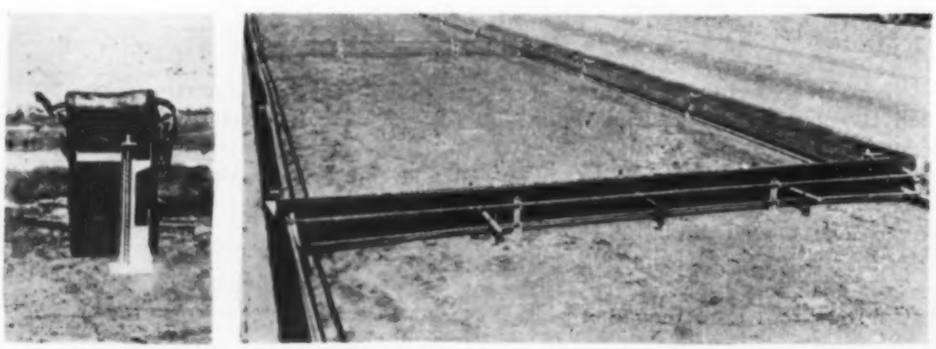
3 CAST-IRON FROG, clamped on side forms, lifts finishing machine and prevents it from pushing over the joint material.

High Production Volume—One mixer used on a portland cement concrete paving project averaged 467 cu.yd. per 8-hr. day for 45 days, operating at 99 per cent efficiency. Two mixers, working side by side, averaged 853 cu.yd. per 8-hr. day for 22 days, operating at 92 per cent efficiency.

Reinforcement—A new type of chair for supporting steel reinforcing bars has been developed, with the driving unit independent of the steel support. This unit has met with immediate approval since it is less difficult to drive and there is very little loss of material due to setting. When a pin is bent in driving it can either be straightened or replaced with a new pin without the necessity of replacing the chair.

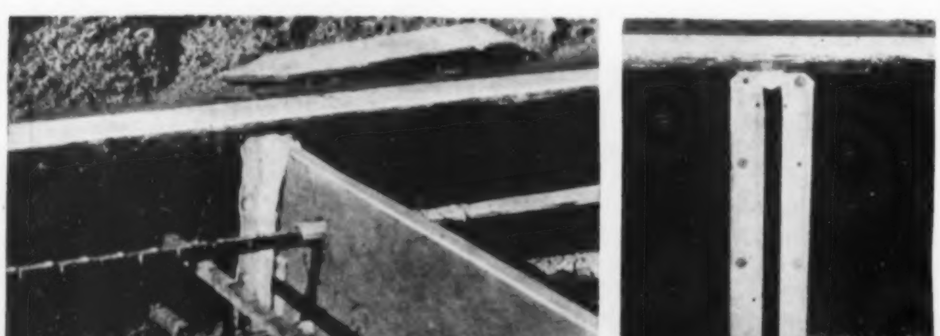
Joint Construction—In placing concrete pavements, difficulty was experienced in keeping the concrete from running around the ends of the joint material, and in order to insure a clean-cut joint throughout the entire width of slab, an end socket of sheet metal was devised which virtually serves as an extension to the joint material.

Considerable difficulty has always been experienced with the finishing machine pushing over the joint material.

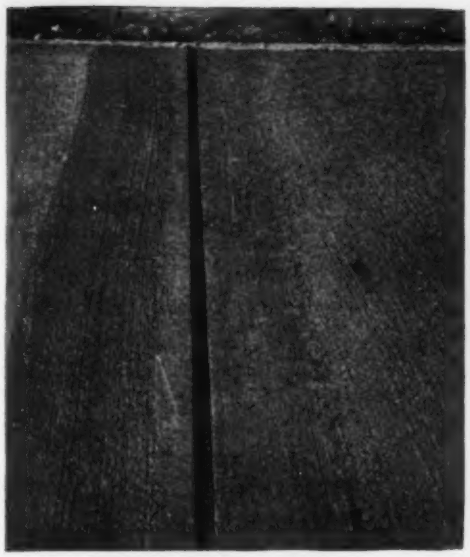


1 NEW TYPE OF CHAIR for supporting steel reinforcing bars has driving unit independent of steel support. Closeup view of chair, at left, and unit supporting steel above subgrade, at right.

4 STEEL CHANNEL SECTION placed over top of joint material and extending 1½ in. down into slab keeps top edge of joint material true to line during finishing operations.

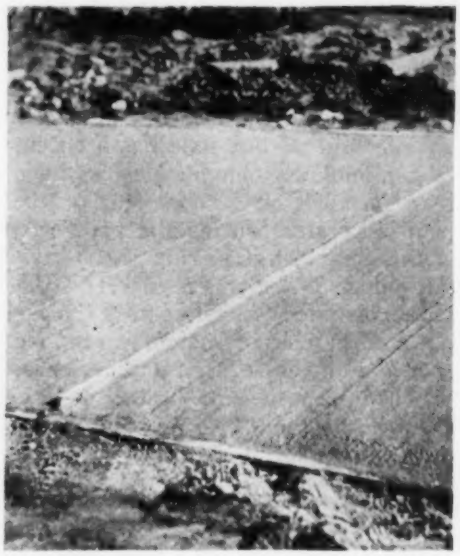


2 END SOCKET of sheet metal serves as extension to joint material, preventing concrete from running around ends and insuring clean-cut joint throughout entire width of the slab.



5 FINISHED JOINT in concrete pavement after removal of steel channel cap.

7 STEEL PLATE *(below)* is used to form dummy joint in which strip of 16-gage sheet metal is embedded after heavy floating is completed.



8 STEEL STRIP is embedded in dummy joint and anchored along lower edge. Upper edge of strip is kept near surface of slab.

To overcome this, a cast-iron frog was so devised as to clamp on the side forms and lift the machine across the joint.

In order to keep the top edge of the joint material true to line during finishing operations and after the removal of the backing plate, a steel channel section was adopted to slip over the joint material and extend $1\frac{1}{2}$ in. down into the slab.

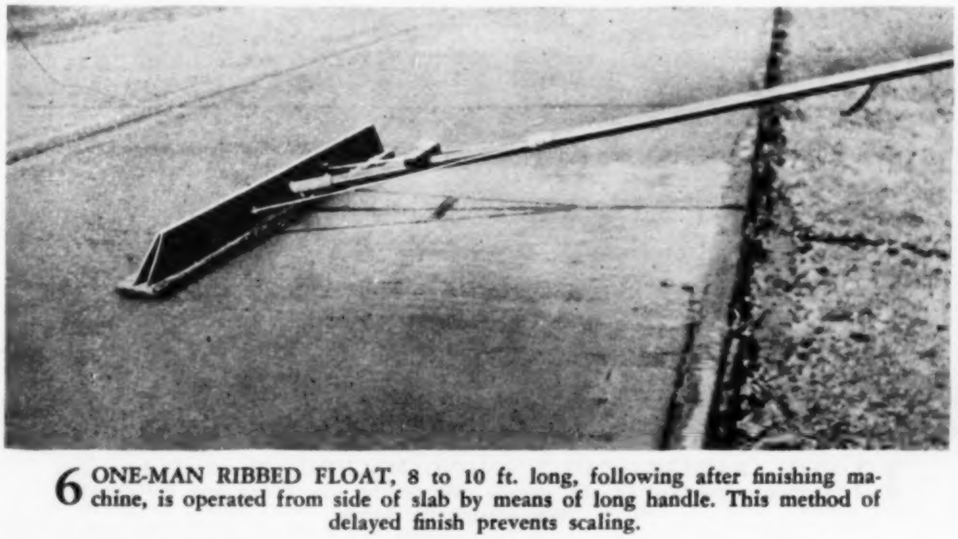
Reducing Roughness—Edging of joints unquestionably adds roughness to the riding qualities of a pavement. To reduce this roughness as much as possible, a dummy joint has been designed that does not require edging. This joint is formed with a steel plate. After the heavy floating is completed, the plate is removed and replaced with a strip of 16-gage sheet metal, having a suitable anchor on the lower edge. Care is exercised to keep the upper edge of this strip as near the surface of the slab as practicable.

Subsequent floating over the joint removes all surface indication of its existence and after a few hours a distinct crack appears which is uniform in all respects. The problem of skewing all transverse joints to reduce the sharp impact of the 90-deg. joint is being given some consideration at the present time.

Finishing—California practice in finishing has been slightly altered. The heavy longitudinal or bull float follows behind the machine finisher, and following this, all subsequent floating is being done with a one-man ribbed float 8 to 10 ft. long, operated from the side by means of a long handle. Usually three of these floats are employed at the different stages of concrete setting, the final floating taking place just as the last free moisture leaves the surface. With this method of delayed finish, there has never appeared any indication of scaling and the roughness of texture obtained is highly desirable.

Curing—In localities where rapid surface drying occurs, hair checking has been practically eliminated by "fogging." Under the fogging method of curing, the slab is kept continually moist while uncovered and, after finishing is completed, it is covered with burlap and kept wet until ponded or covered with an earth blanket. Fogging is often practised along with the finishing and floated in to the surface. Tests made with a surface hardness determining device developed by the U. S. Bureau of Public Roads show that this surface retempering does not decrease the surface hardness, and in some instances it shows an increase in strength over the normal curing methods.

Bituminous Paving — Production plants for bituminous mixtures have been materially improved in the last few years. Capacity of mixers has been increased to as high as three tons. Improved methods of feeding and stor-

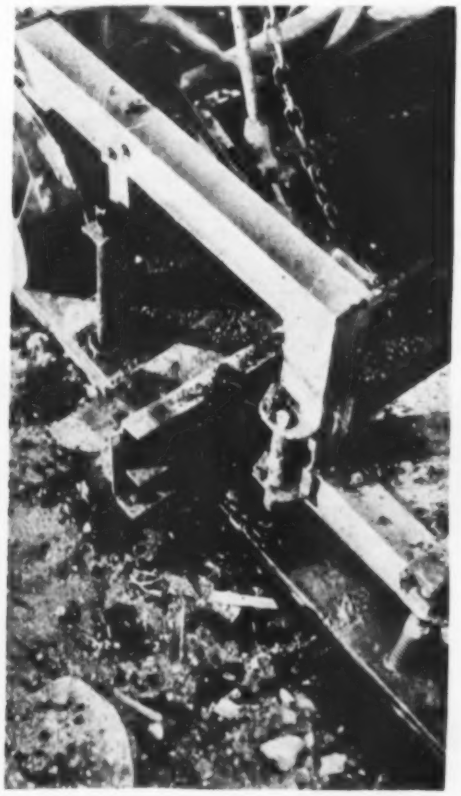


6 ONE-MAN RIBBED FLOAT, 8 to 10 ft. long, following after finishing machine, is operated from side of slab by means of long handle. This method of delayed finish prevents scaling.

9 FLOAT is used to give final finish to dummy joint.

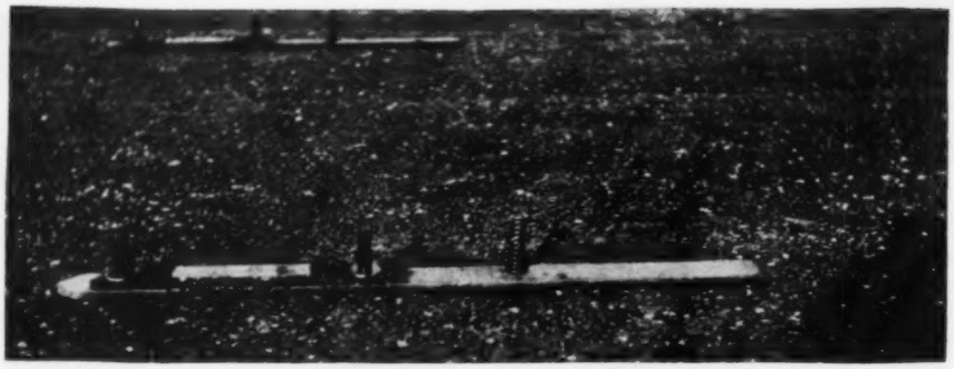
age capacity of heated aggregate have been developed to keep these plants operating at maximum capacity. Mixer gates have been so perfected that a batch may be discharged in a very few seconds and all lost time has been cut to a minimum. Timing devices have been installed on 50 per cent of the plants operating during the past year.

On one project an automatic proportioning device was used. This device, operated by hydraulic jacks powered by electric motors, opens one gate and holds it open until the set weight is deposited in the weight box, then closes the first gate and opens the second gate in the order predetermined. Four separate mixes may be set up at one time and the change from one mix to another is instantaneous by means of a selective switch. The rotation of pull on the bins can be set in any way desired.



10 **TRAVELING TRACK is dragged along under screed of mechanical spreader and finisher for bituminous pavements, eliminating necessity of carrying track ahead. For track detail see photograph No. 11.**

Spreader boxes are universally used to distribute the truck loads of bituminous mixture. The finishing machine has been quite generally adopted, and various improvements have been made upon it from time to time since its inception several years ago. A traveling track arrangement has been perfected that drags along under the screed and eliminates the necessity of carrying track ahead.

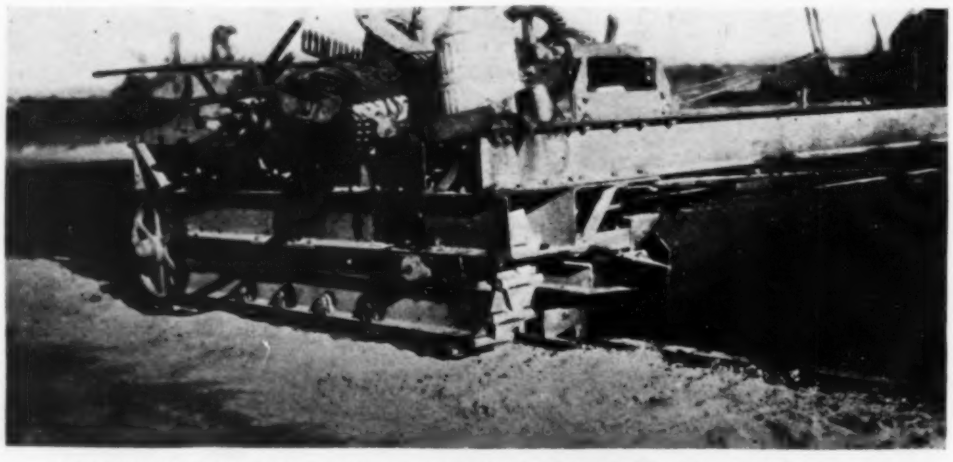


11 **DETAIL OF TRAVELING TRACK detached from bituminous finishing machine illustrated in photograph No. 10.**

One machine has been constructed in California that operates on a caterpillar tread running just outside the side forms, the screeds riding on the side forms as in the other models. This design has many advantages over previous machines. The rake design has been improved by changing the motion to a direct fore and aft movement which gives a combing action to the mix.

12 **CRAWLER TREAD, running outside of forms, has been developed for bituminous finishing machine.**

Greater smoothness of finished surface is being obtained by substituting a direct cross-roll with the first tandem roller behind the 3-wheeler on initial compression instead of the former practice of diagonal or half circle rolling. In this cross-roll every square foot of the pavement is covered, and if the shoulder width permits, all turning of the roller is done off of the pavement. The smoothness of asphaltic surfaces now approximates that obtained on our portland cement concrete pavements.



13 **WITH CRAWLER-TREAD FINISHING MACHINE, illustrated above and in photograph No. 12, the screeds ride on the side forms, but the crawlers run outside the forms.**

EXCAVATION OF FOUNDATIONS for Rockefeller Center buildings involves drilling of great quantities of Manhattan schist, containing large proportion of free silica. High concentration of fine silica dust in air breathed by drill runners is fruitful cause of pulmonary diseases.

New Types of Suction Hood REMOVE DUST HAZARD *From Rock Drilling*

IMPROVED types of Kelley dust traps to reduce the silicosis hazard in rock drilling were recently demonstrated at Rockefeller Center, New York City, by George S. Kelley, mechanical engineer of the George J. Atwell Foundation Corp., and his associates. The demonstration included dust traps used with jackhammer, drifter, and stopehammer drills. In principle, the method of dust removal was the same as that employed with jackhammer drills on the foundation of the Metropolitan Life Insurance Co. building, described in *Construction Methods,* March 1932, pp. 24-26. This method depends upon a separate exhaust system to take away dust from the drills and to deliver it to a central collecting plant which removes the dust before discharging the exhaust air.

No attempt is made in any of the three types of dust traps to obtain a tight seal between the hood and the rock surface or between the hood and the drill steel. The inrush of air into the trap prevents the escape of dust and carries most of the particles through the exhaust outlet, reducing the dust concentration in the zone breathed by the operator below the hygienic safe limit. A drill runner on hard rock excavation or tunneling can work in an atmosphere of this safe dust concentration without danger of

UNDER USUAL DRILLING CONDITIONS, jackhammer drill creates great cloud of dust. Concentration in zone breathed by drill runner ordinarily is far higher than hygienic safe limit.

DUST TRAP connected by exhaust line to dust-collecting plant captures both visible and invisible dust, reducing concentration in air breathed by drill runner below hygienic safe limit.

having his lungs injured by an excess of fine silica particles.

Dust Traps—In outward appearance, the improved Kelley dust trap for jackhammers is similar to that used on the earlier foundation work. It is a sturdy metal chamber shaped like an inverted dipper and provided with a side outlet which is connected to the exhaust system, as shown in one of the photographs. The trap is split and equipped with a spring hinge to allow easy insertion of the drill steel, which passes loosely through a hole in the top. An inner jacket, to be seen in another photograph, concentrates the stream of inrushing air at top of the drill hole and captures the dust.

The dust trap for a drifter is cylindrical in shape and is made of reinforced rubber, split longitudinally to permit rapid changing of drill steel. To support the trap at all angles of drilling, above and below the horizontal, a tubular bracket has been devised which is attached to the shell of the drill. An axial adjustment in the support permits the operator to bring the hood in satisfactory contact with the rock surface.

To support the heavy molded rubber hood used in connection with the stopehammer, for drilling in vertical position or at angles close to the vertical, an auxiliary pneumatic column is provided. This auxiliary column is secured to the toe of the main drill column and is held in position parallel with the drill by two clamps, attached to the latter, which travel along the auxiliary column as the drill progresses.

In actual excavating operations of the George J. Atwell Foundation Corp.

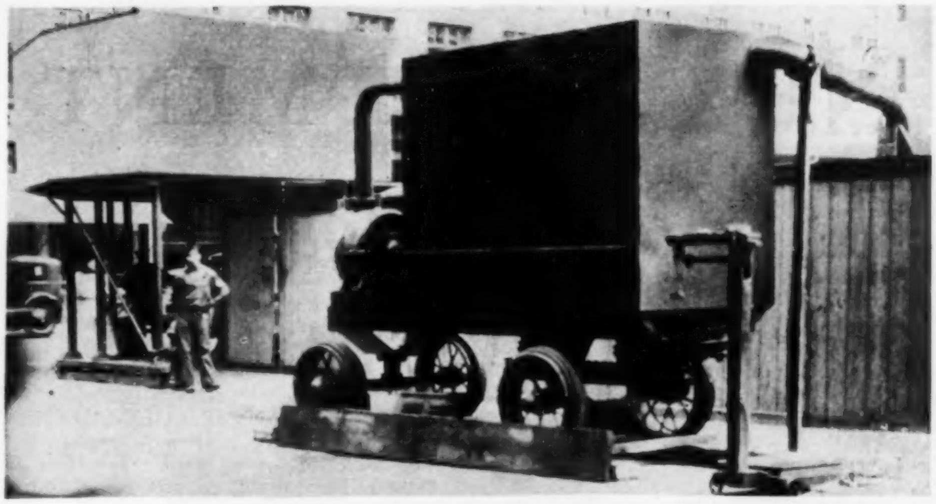
BATTERY OF SIX JACKHAMMERS operated for demonstration purposes without suction hoods produces choking cloud of dust and causes general exodus of spectators.

JACKHAMMER TRAP is opened by turning back hinged segment to permit rapid insertion of drill steel.

SUCTION HOODS for drifter (at left) and for jackhammer. Inner cone of jackhammer trap concentrates inrushing stream of air at top of drill hole.

PORTABLE DUST-COLLECTING PLANT with capacity of 12 jackhammer drills requiring air flow of 100 cu.ft. per minute each is equipped with fan which creates suction to operate entire system. Incoming air enters preliminary separation chamber, where heavy dust is removed, and then passes through fabric filters before being discharged.

WITH DUST TRAPS IN OPERATION, battery of jackhammers at demonstration creates no health hazard for drill runners and causes no discomfort to spectators. Reinforced rubber hoses from dust traps are connected to manifold connected, in turn, by larger hose to pipe line leading to dust collecting plant.



IMPROVED TYPE of dust-collecting plant has more efficient preliminary separation unit which reduces load on fabric filters by one half.

at Rockefeller Center, jackhammer drills only are used, the drilling and blasting being carried forward by the usual benching method. Dust traps at the rock drills are connected by hoses to a manifold connected in turn by a larger hose to a pipe line leading to the dust-collecting plant.

Dust Collectors—Efficient removal of dust from the Ingersoll-Rand S-68 jackhammers used on this project requires an air flow of 100 cu.ft. per minute per drill. Two portable dust collecting plants of sufficient capacity to take care of 12 drills each are placed on street level at the edge of the excavation. In general, each dust collecting plant consists of a preliminary separation chamber which removes most of the heavy dust, a secondary fabric-filter unit which cleans the air for discharge, and an exhaust fan which induces the necessary draft through the entire system.

Rate of Drilling—Jackhammer drilling tests conducted with the older type of hood used at the Metropolitan Life Insurance Co. building indicated that the dust trap increases drilling speed. Rates of drilling were obtained, using the same drill with and without the dust trap. Freshly sharpened drill steel was provided throughout the tests, and all drilling was done in a small area to assure uniform rock conditions. To eliminate the human element, dead weights were applied continuously to the drill, the drill runner merely operating the machine and steadying it during operation.

Two weights were used: 20 lb., which represents the average force applied through the drill runner's arms, and 40 lb., which is approximately equivalent to the force applied when one leg is rested over the head of the drill. The drill was operated for two 1-hr. periods under each condition. Results of the tests, averaging the two 1-hr. periods in each case and comparing the averages, show an increase in rate of drilling when the dust trap is used of 21 and 11 per cent for the 20- and 40-lb. weights respectively.

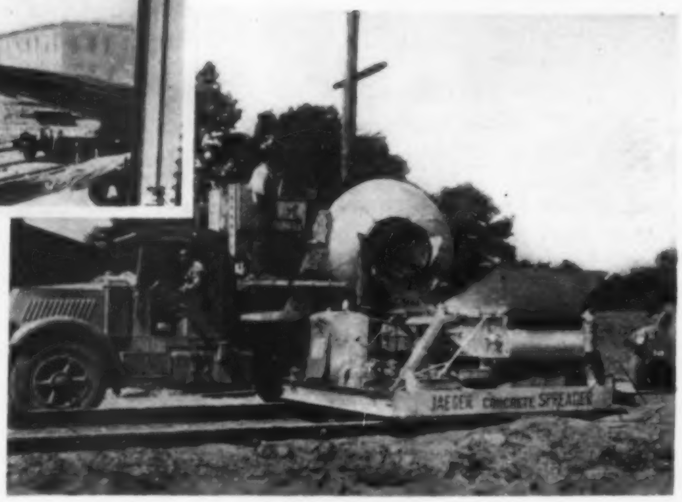
Collaborators—Cooperating with and assisting Mr. Kelley in the development and testing of the dust traps and dust-collecting plants are Theodore Hatch, instructor in industrial sanitation, Harvard University, and J. William Fehnel, chief chemist, laboratory of industrial hygiene, Metropolitan Life Insurance Co.

DRIFTER DRILL operating without dust trap puts tremendous quantity of visible and invisible rock particles into atmosphere, with eventual detriment to health of drill runner.

MOLDED RUBBER SUCTION HOOD captures stream of dust rising from drill hole. Dust traps are not intended to form sealed contact with rock surface.

NEW EQUIPMENT *on the Job*

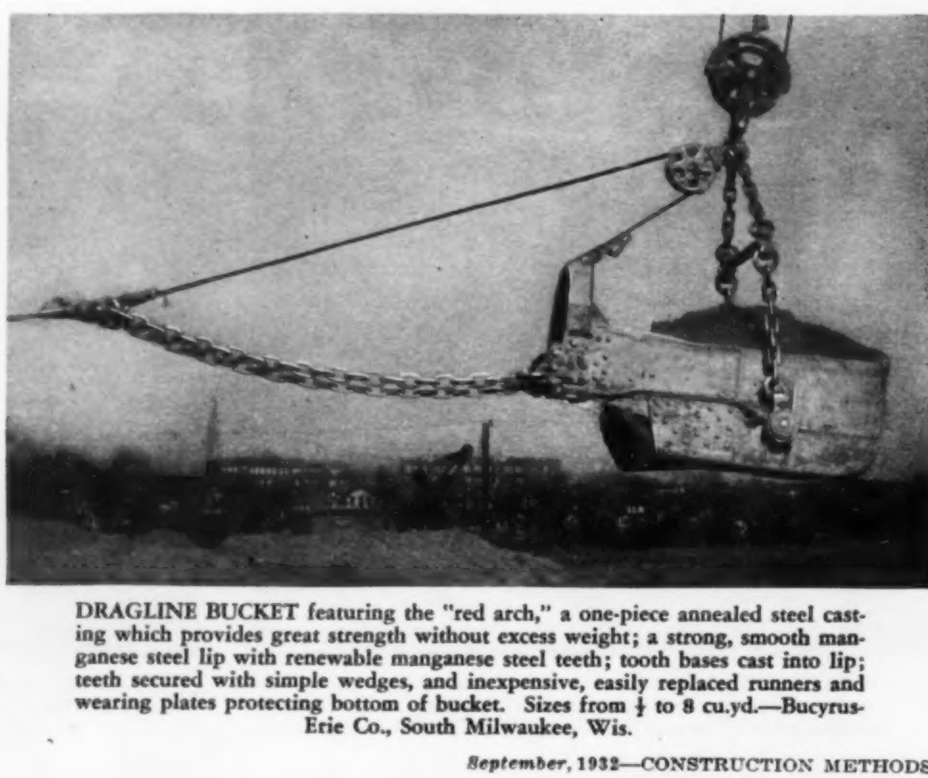
AUTOMATIC CRANE SCALE placed in lifting line combines weighing and handling of loads in one operation. Indicates weight of load on large dial as soon as load is lifted clear of its support. Design of dial mechanism provides one-point adjustment and permits tester to locate and seal every graduation point from zero to capacity. Two types—regular for general use, and low head for use where head room is limited. Capacities 750 to 50,000 lb.—Kron Co., Bridgeport, Conn.



TRUCK MIXER WITH DUAL SIDE DISCHARGE for use in highway and curb and gutter construction makes possible dumping of 2½- to 5-cu.yd. batch of concrete from either side of drum in less than 1 min. Side discharge mounting permits use of mixer longitudinally of work, thus eliminating delay of backing and turning truck. Concrete spreader used in connection with truck mixer provides for rapid distribution of concrete.—Jaeger Machine Co., Columbus, Ohio.

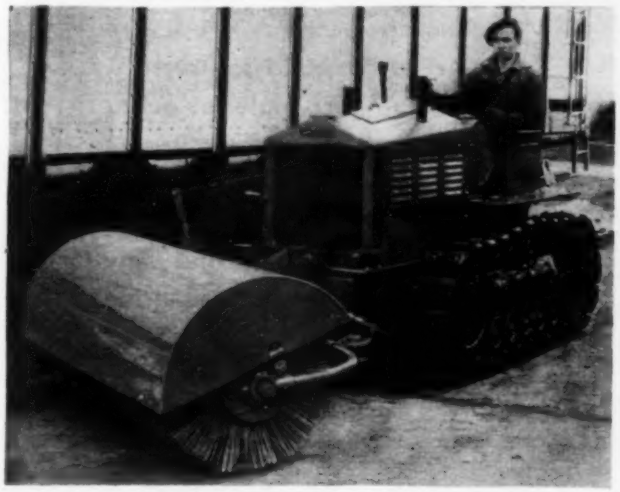
ALUMINUM HOPPER RAILROAD CARS designed to carry heavier payloads without increasing gross load. Considerably lighter than those constructed of other metals. — Aluminum Co. of America, Pittsburgh, Pa.

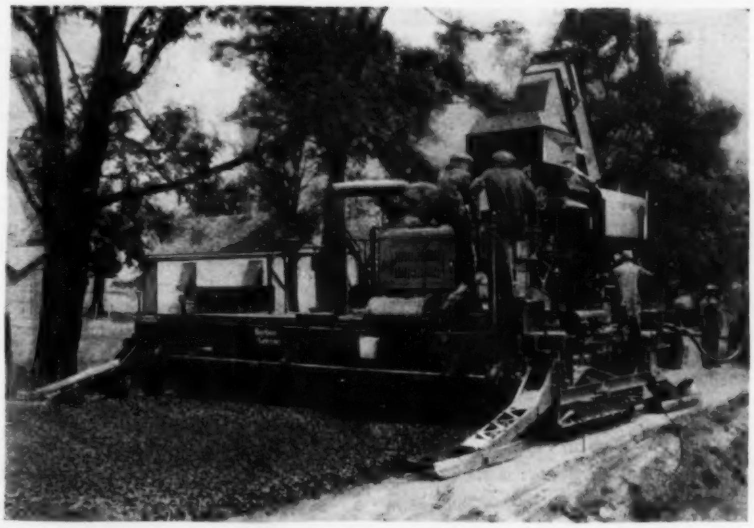
GENERAL SERVICE CENTRIFUGAL PUMP *(below)* with capacities from 5 to 800 gal. a minute for heads up to 100 ft. and in ½- to 25-hp. sizes. Both pump and electric motor assembled as single unit and mounted on same shaft. No coupling or base-plate needed. Can be mounted in any position. Furnished with open-type, totally enclosed, or explosion-proof motor.—Ingersoll-Rand Co., Phillipsburg, N. J.



DRAGLINE BUCKET featuring the "red arch," a one-piece annealed steel casting which provides great strength without excess weight; a strong, smooth manganese steel lip with renewable manganese steel teeth; tooth bases cast into lip; teeth secured with simple wedges, and inexpensive, easily replaced runners and wearing plates protecting bottom of bucket. Sizes from ½ to 8 cu.yd.—Bucyrus-Erie Co., South Milwaukee, Wis.

SWEEPER AND SNOW BROOM *(below)*, 6 ft. wide, easily and quickly attached to front of Cletrac "15" tractor, moves forward at 35-deg. angle and cleans 5½-ft. wide space of snow or of dirt. Permanent adjustable stop allows broom to raise and prevents it from digging into ground. Used as street cleaning unit in winter and summer and also for clean-up work in and around industrial buildings.—Manufactured by Detroit Harvester Co., 5450 W. Jefferson Ave., Detroit, Mich.





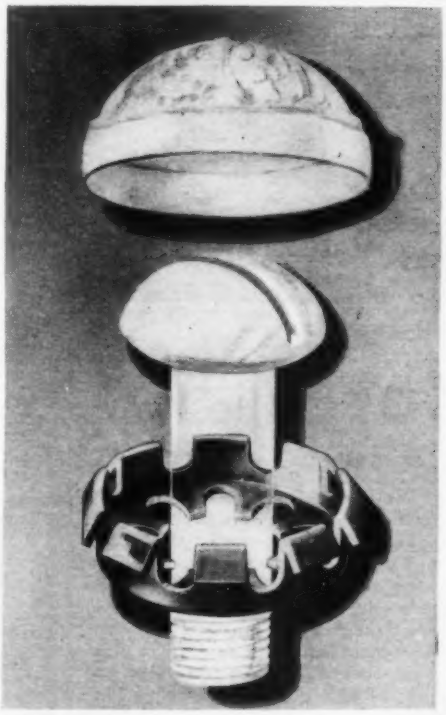
BITUMINOUS PAVER AND FINISHER, a three unit machine, consists of loader, mixer and finisher. Loader handles grading, light excavating, stock piling and reclaiming and transfers aggregates to the mixer. It also is equipped with two 400-gal. tanks for carrying oil or asphalt. Mixer, equipped with own 82-hp. plant and a positive feed pump, receives aggregates and oil or asphalt from loader and produces either hot or cold mix. Finisher spreads, compacts and screeds mixed material. All units may be used independently.—Barber-Greene Co., Aurora, Ill.

ROAD DISK for cutting sod on grassy road shoulders, disking earth fills on grading work, mixing materials on retread jobs, making and maintaining sand-clay roads and cinder streets. Baker unit has lifting range of 5 in. below and 10 in. above bottom of wheels. Powered by Caterpillar tractor of 20 hp. or more, depending upon depth of penetration.—Caterpillar Tractor Co., Peoria, Ill.

If You Want Further Information

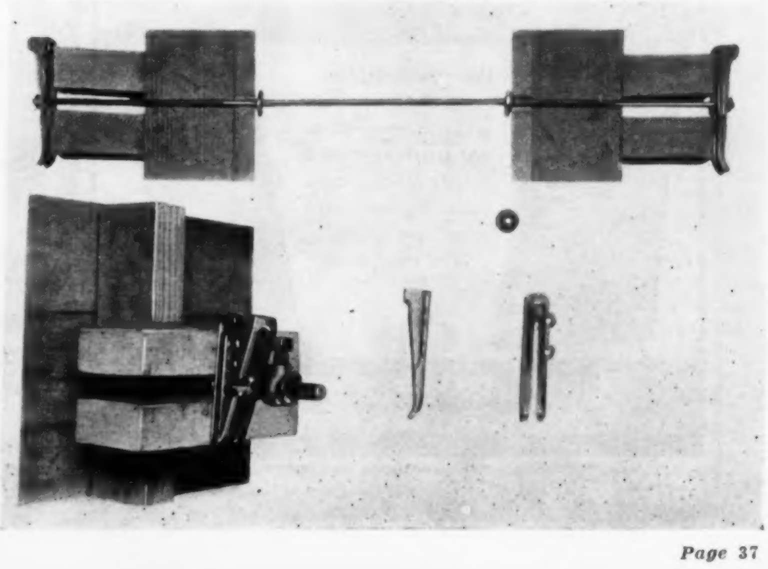
Within the space limits of these pages it is impossible to present complete information about the products illustrated.

The manufacturers, however, will be glad to supply further details if you will write to them, referring to this issue of *Construction Methods.*

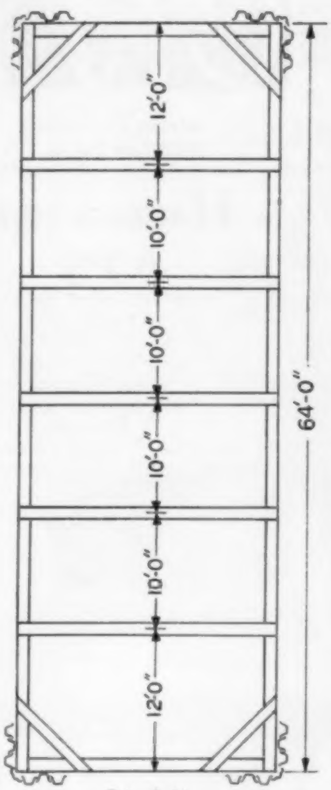


LOCK WASHER combined with ornamental metal cap for sealing and concealing bolts, screw heads or nuts. Washer is made of spring steel to fit all sizes of bolts and screws and has four-point locking arrangement. Rust-proof caps of drawn metal or molded bakelite, either plain or embossed. Named "Lok-Crowners" and made by Rawlplug Co., Inc., 98 Lafayette St., New York City.

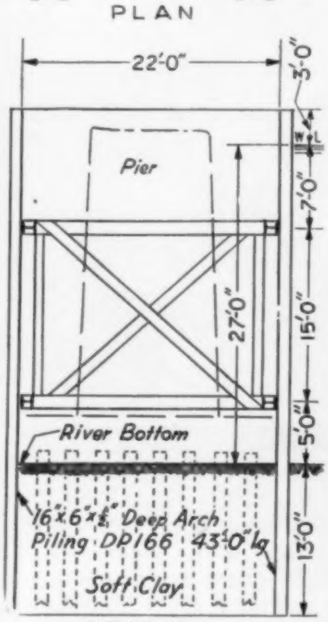
SPREADER, FORM-CLAMP AND MIDGET WEDGE *(right)* for holding forms in proper position. Spreader (top) in sizes to 24 in., has round washer on rod to prevent concrete from seeping through rod holes. Malleable iron form clamp (lower right) with wedge form one unit and can be applied in 15 sec. Front and side views of wedge (lower right).—Frederick N. Ritchie Co., 113 North Center St., Orange, N. J.



HOW DEEP-ARCH PILING
saved Time and Money on this job

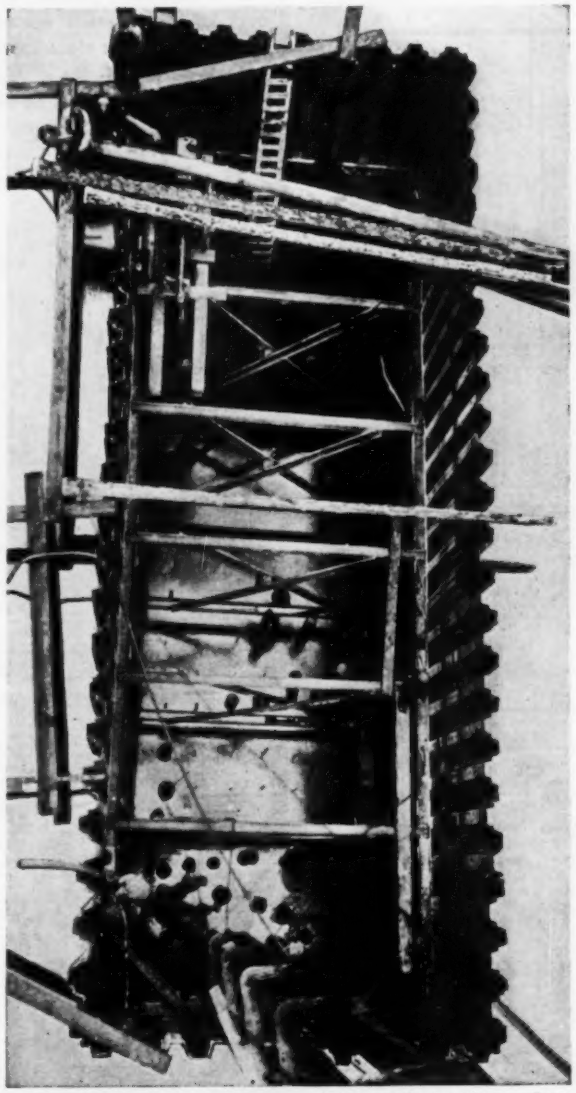


PLAN



SECTION

The section and plan shown above make clear the simplicity of the steel bracing. H-Columns were used as struts, Girder Beams as wales, and Channels as posts and diagonal braces. 225 tons of Bethlehem (Lackawanna) Deep-Arch Piling, DP 166, were used in the two cofferdams.



These illustrations show one of two cofferdams for Dickey Place Bridge, East Chicago, Ind., built of Bethlehem (Lackawanna) Deep-Arch Piling with steel bracing. *Contractor: Great Lakes Dredge and Dock Company*

THE photographs show one of two steel-braced cofferdams, built of Bethlehem (Lackawanna) Deep-Arch Piling and used in the construction of the Dickey Place Bridge over Indiana Harbor Canal, East Chicago, Ind.

Although the cofferdam stood in 27 ft. of water, two tiers of steel bracing were sufficient to support the walls, due to the high transverse strength of the piling. This simple frame was much less expensive to install than complicated timber bracing, and greatly facilitated the pouring of concrete. The bracing was left embedded in the concrete; none of it was removed during the pouring operation. After pouring was completed, the ends of the cross-bracing projecting beyond the concrete were burned off.

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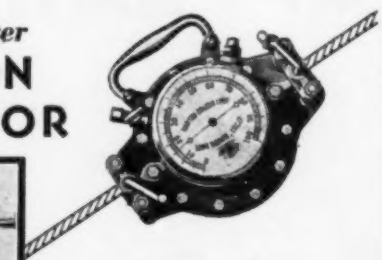

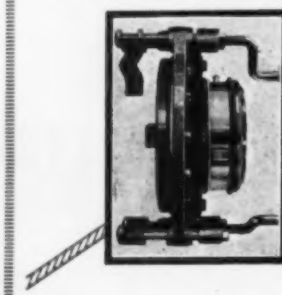

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ALPHABETICAL INDEX TO ADVERTISERS

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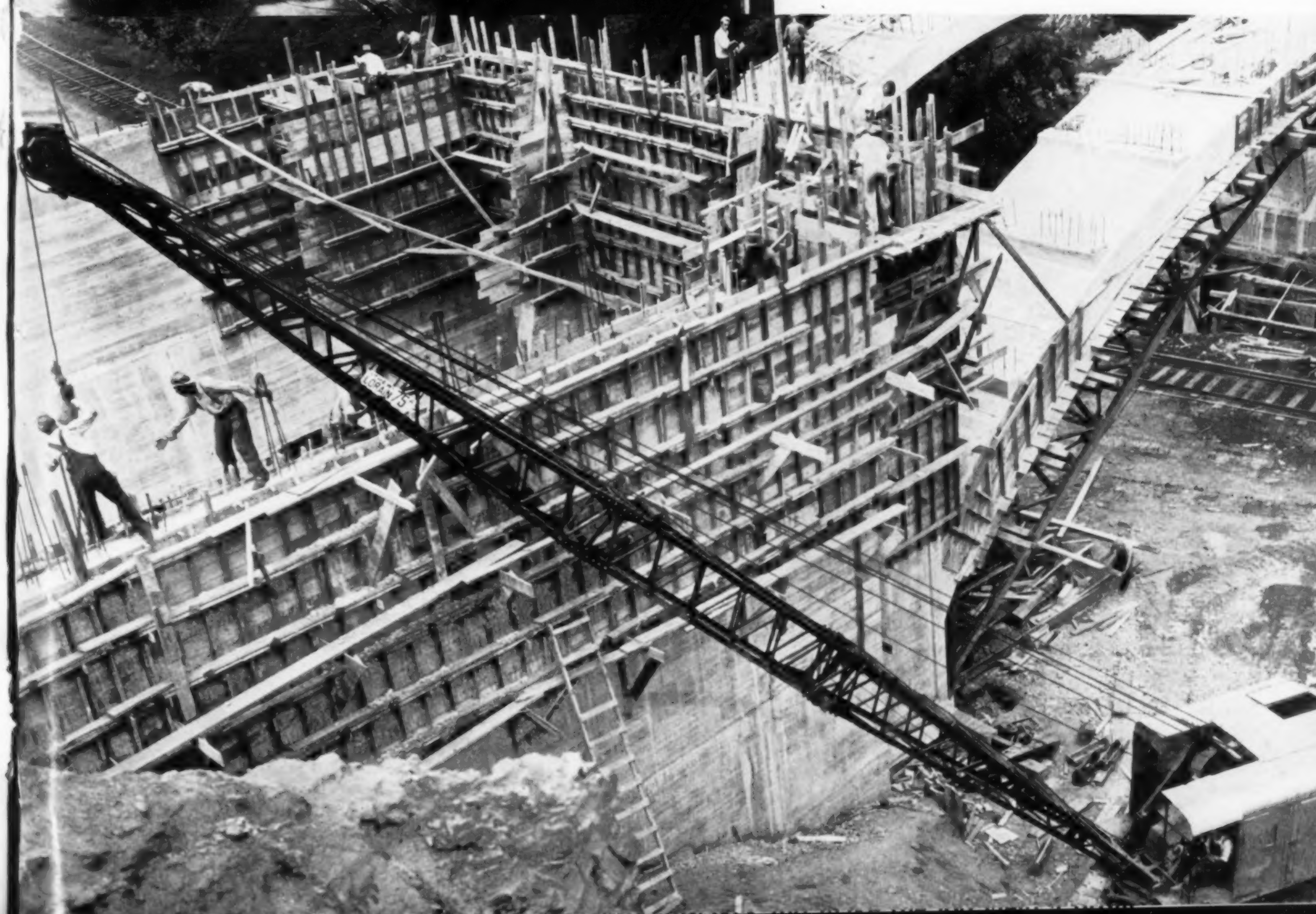
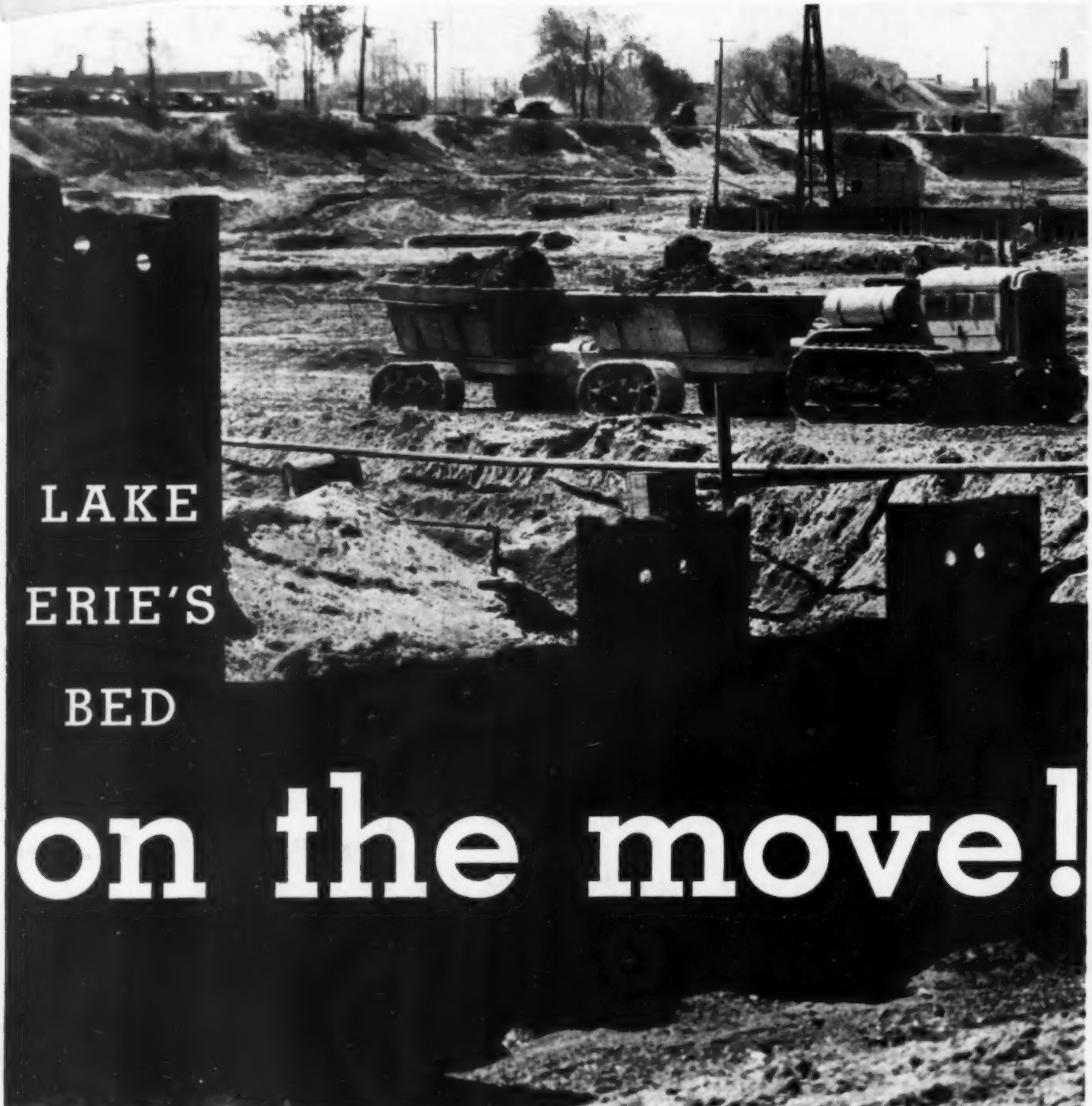
KILROY STRUCTURAL STEEL





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